REPORT OF

EIGHTH ANNUAL
Date Grower's Institute

HELD IN

COACHELLA VALLEY

CALIFORNIA

APRIL 3-4, 1931

Held under the auspices of and published by the
Coachella Valley Farm Center

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Care of the Deglet Noor Date Bunches from Pollination to Picking

By Leonhardt Swingle, Indio, California

THIS paper, dealing with the care of dates from pollination on to picking, is in no sense a record of original work or a report of new practices. A great many of the practices given have been reported in previous papers at the Date Institute. Practically all of them are in use by different date growers over the valley. This paper is written with the hope that a compilation of these practices and putting them in one place will be of benefit to present and future growers.

It would seem offhand that there is little need of such a paper, but anyone who works with, and observes the dates as they are harvested, is most forceably struck by the need of better practices on the part of the growers. People overlook or neglect some details, and the result is a poor size or quality of the crop. Hence the idea of the bringing together of these practices in one paper with the hope that it will be of benefit to the date growers.

The first criticism that may be offered to this is, "Why go to any expense in growing better dates when we can't get any more for good dates than poor ones?"

For three years the writer has been a seller as well as a grower of dates, and in my position there is no argument as to the benefit of quality. It may mean the difference between a sale or no sale. When a man comes to buy dates with the money in his hand and will take all you have and wants more of a good grade; and when you cannot get more than a tentative and half-hearted offer on poor stuff and only at a part of the price of the good dates; then you appreciate quality. Good fruit moves readily at a profit, and poor fruit goes at a loss. When this happens not once but again and again, you then know above all argument that quality is the all important point between success and failure. Quality is the best salesman of California dates we can get. Any practice that improves the grade of the crop is worth while.

It must be stated right now that the practices given in this paper are for the Deglet Noor variety alone. Each variety differs in its proper handling in many important details, and the care of other varieties will be discussed by Mr. Russel in another paper. Many people have worked with the Deglet Noor for many years, and the practices are fairly well worked out for that variety.

Let us start briefly with the care of the pollen. While we must first have a good male, it is not the province of this paper to discuss that part. Let us assume that we already have a good male with flowers ready to open. It is advisable to cut the male bloom as soon after it splits the sheath as possible. We have found it advisable to look at our male trees twice a day, as a bloom that is open and exposed on a warm windy day for as much as twelve hours will lose much of its pollen. Perhaps with experience we can cut the male bloom just before it cracks, which will be better yet.

Some growers then take the bloom and allow it to dry and the pollen to shed, collect the pollen and use it on cotton or other materials. In such case, the bunches are hung up in a tight room or closet, and the pollen caught and kept in a cardboard box or bottle. The pollen must be kept dry, exposed to air, and not allowed to mold. There are various arrangements for doing this work, which I will not describe.

The writer has used the method of taking the male bloom, and, as soon as cut, cutting the threads off the blossom and spreading them out on a newspaper, about one bunch to a lug box, and allowing them to dry. These threads turn dark but keep the pollen in perfect shape. Two or three threads are then used in pollinating each female bloom. I may say that this is exactly the method shown me eleven years ago by Fred Johnson, and I have used it without change all this time. Some people prefer to use the threads, and some the cotton. I do not know that there is much difference, but it seems to the writer that the pollen will go further and is less trouble to handle by cutting the threads off and using the threads to pollinate.

The only difficulty in storing pollen during the season is in having it exposed enough to the air so that it will not mold. Ordinarily there is little trouble in this respect, but this past season during our week of rainy, humid weather at the start of pollinating, several blooms on my ranch molded because of excessive moisture. Once in a while an early bloom will be caught by a frost, and part or all of the bloom will be black and useless when it opens. Later blooms on the palm are not so affected.

There is some talk of the benefit of mixing the pollen from different trees in order to insure better pollination. This is not necessary in a variety so easily pollinated as the Deglet Noor. In some varieties this probably has a good deal of merit. The Deglet Noor takes the pollen very easily, and any good pollen will serve. To secure uniformity of fruit, it is far better to pollinate from one good male rather than mix different males on the same bunch or even in the same garden. The writer uses just one male in pollinating the whole garden, except occasionally when it is necessary to help out with another.

In pollinating the female bloom, it is best to do so as soon as the bloom cracks the sheath. The Deglet Noor will remain receptive for several days, or a week, and it is not necessary to go over the garden every day. An experienced person could probably gauge the maturity of the bloom and be able to open the sheaf and pollinate the bloom just before it naturally opens; but the ordinary person doing the pollinating had best allow the bloom to open naturally, as I feel there would be some danger to the flowers in opening them several days before they were ready.

The best practice is to cut one-quarter to one-third off the end of the bunch when pollinated. To cut more than one-third may result in too severe pruning on some bunches, which will be hard to remedy at the

regular thinning time later on and will mean overgrown fruit. Practically every bloom is better with at least one-quarter cut off. One-third to one-quarter is the best practice to cut off when pollinating, and the final adjustment is made from this start.

The sprigs of pollen, or cotton, that we have spoken of previously, are inserted in the bunch which is then tied with a string. Various kinds of strings are used. They should be about three feet long, strong enough so the bunch will not break them, and tied with some form of slip knot so that they will hold the bunch together, but slip out enough so the bunch is not choked. Several forms of knots are used, and there is a patent tie now that is in use by some growers. The writer uses a No. 36 hard, twisted, cotton seine cord. This is uniform enough to slip easily and strong enough to hold the bunches so they do not break and become tangled in the leaves. The idea of using string of the right strength and quality is to keep the bunch tied in without further care or attention on the part of the grower from the time of pollination until the bunch has grown out and the dates are heavy enough to bring it down, at which time the second thinning can be done. If the bunch grows out in the top of the tree and then the string breaks, the dates will be tangled in the leaves in about as difficult a position to care for as can be imagined. The threads will be broken, dates badly scarred, and, unless they are brought down at considerable trouble and expense, they cannot be thinned or even picked. It is, therefore, extremely important that the string and tie we use hold these bunches under control so they do not become tangled in the leaves and will come down of their own weight when the young dates are heavy enough.

There is one very important detail, which is usually mismanaged by the inexperienced person, and this is: The thread used in tieing the bunch should be put far enough down on the bloom so that there is no danger of it slipping over the end. The inexperienced person is very apt to leave this tie only an inch or so from the end of the bunch; in which case a considerable percentage of the blooms will slip out of the strings—just push the string off the end, so to speak. The tie should be placed well down on the bloom, six inches or more.

If we have used a good tie and string at pollinating time, we can, therefore, forget the dates until their weight brings them down about six weeks or two months later. They are now within reach, and the bunches are far enough along so that we can do a real job of thinning. We have already cut back one-quarter to one-third of the ends of the threads in pollinating. We now look at the bunches and see that some will need more cut off. The best practice seems to be to leave from 25 to 35 dates on a thread at this time. This number seems to depend largely on the number of threads that are left on the bunch.

If we left, say 25 dates, then apparently we can leave 40 to 50 threads. If we leave 35 dates, then we should leave 30 to 40 threads. Observation shows that if more than 35 dates are left, a proportion of them are apt to shrivel or dry up, or never make good size. It does not seem possible to draw enough nourishment through one thread to properly nourish all the dates nature puts on that thread. Nature will grow the seed and then give us a shrivelled, small date. These figures show approximately a thousand to twelve hundred dates to the bunch. Leaving all of the threads and all of the dates will give us some 2500 dates to the bunch (counting 50 threads and 50 dates to the thread), but I do not believe there will be any more pounds of fruit in these 2500 dates than in a thousand good dates.

Another thing we do at this time is to cut the center out of the bunch. The size of the bunch has something to do with the number of threads left. As I have indicated, this will be somewhere around 40 threads.

There are two forms of date bunches. One has a long axis running out through the center of the bunch with threads of dates given off from this axis. It is very important to cut the end off of this form of bunch. This is what we mean by cutting the center out of the bunch. The other form of bunch has the threads all coming out from very nearly the same point. There is no long center axis. The center of this bunch, so to speak, has never developed. While it is equally important to reduce the number of threads on this bunch, it is not so important as to just which threads are cut. We cut them off in the center to open up the bunch, or cut off the bruised or injured threads outside. The string used in pollinating is now taken off, and a good practice is to lay it around the stem where it is ready to use in tieing the bag or cover applied when the dates ripen.

The question of how many bunches to leave to the tree comes back to the size and vigor of the tree, and this is something for the individual growers to determine themselves. It will, of course, depend somewhat on the size of the bunch we have left in our thinning, but, nevertheless, this question is something that only the grower can determine in his own garden. In my case, I leave 12 to 15 bunches. My bunches run between 20 and 25 pounds to the bunch.

The people will have different results and different ways of determining the amount of fruit on the tree. It depends on the vigor of the tree and the food, water and care it gets. This is where the owner's judgment comes in. Our yield is determined by the number of bunches the tree can carry; our quality largely by the method of thinning and care of the individual bunches.

Several years ago the writer noticed that on a great many bunches black nose, or rather "sugar tip," was much more severe in the center of the bunch than on the strands exposed to the outer air. This observation with some experimentation led the writer the past season to put a metal ring in the center of the bunch so that an open channel for air circulation is left in each bunch. Some people will say that by properly cutting out the center, such a channel is left natually, and no ring is needed. At the time the center is cut out in May or June there is a very obvious hole left in the bunch, but as the dates increase in size and weight, this center closes up, and in August and September the dates will be all pressed together with no sign of an opening. For this reason the ring is used, and while the writer certainly does not recommend them as a cure for this trouble, he believes that they help.

The rings used were made of wire 16 inches long. Some were made of galvanized wire by a blacksmith. some were made on the place from heavy copper wire. At the present price of copper, probably the cheapest and most satisfactory rings can be made of about No. 8 copper wire. They are strong enough so there is no danger of them collapsing with the weight of the fruit and pliable enough so that they can be bent into a ring by the fingers. Naturally they can be used many years.

Several years ago a great deal of thought and attention was given to the propping or support of the bunches, but as the trees have become older and stronger and the bunches have been carried up away from the ground, most of this propping has been found unnecessary. Sometimes a bunch will become twisted over a leaf or comes out of the tree at such an angle that it is necessary to prop it even on an old tree, but the great majority of bunches on mature trees will support themselves, and there is less danger of breaking when they are allowed to do so than when they are supported. On younger trees in which the fruit will hang on the ground, it is absolutely necessary to support the bunch. This is done by using an inch square date prop about 6 feet long and usually attaching to this the common metal hook so widely used. It is possible to replace the hook by a string tied in two places on the date bunch and supported by the same wooden prop, but the hook is most widely used. It is absolutely necessary where the bunch will lie on the ground that it be supported by a prop. But as I said before, not nearly so much propping is done now as was the case several years ago.

About the only other care needed by the fruit during the summer is to sulphur once or twice for the date mite. Once is usually enough, but if there is any doubt, it should be done twice.

Common practice is to use flowers of sulphur in a small knapsack or hand duster. A few puffs to the bunch is all that is necessary. If the date bunch is wet, sulphur will cling better and will be noticeable all summer, but most sulphuring is done on the dry dates and perfectly satisfactory results are obtained.

There is, however, one very important point in sulphuring. If you wait until the mite is apparent on the dates it is too late, and you have already suffered a loss in grade by the mite. You absolutely must put the sulphur on in plenty of time—at least once whether they need it or not. It does not cost much, and if you are busy on something else and let it go for a few weeks, the mites make culls out of your crop.

A good deal of criticism against sulphuring arises from the fact that it is applied to dates already ruined by the mite, in which case it clings to the surface of the date even when the date is ripe, and it is almost impossible to remove by our cleaning methods, and the statement is made that the sulphur has ruined the dates. As a matter of fact, the dates were already ruined by the mite before the sulphur was put on. When the sulphur is applied in time, it will completely control the mite, and no sulphur will be left when the dates ripen.

The only remaining practice in caring for the growing dates is bagging or covering, but this is too big a subject, with no very satisfactory details or methods worked out, to be discussed in this paper.

Let me state again that the details given in this paper are applicable to the Deglet Noor variety alone. Mr. Russel will discuss other varieties.

I will, however, give an illustration in the case of the Ashrasi to show the difference between that variety and the Deglet Noor. The Ashrasi is notoriously hard to pollinate, and as I have a tree and have worked with it for several years, I believe that this arises from three things.

We need to observe three conditions to pollinate the Ashrasi. First, we must have a suitable male. Most males will not pollinate the Ashrasi. Here let me remark that most males will pollinate the Deglet Noor. Having found the male, it seems that the most susceptible flowers on the Ashrasi bloom are at the tips of the bunch. If we cut off our third or quarter, as we do in the Deglet Noor, we will cut off three-quarters of our crop. It is, therefore, absolutely necessary that this variety be not cut back at pollinating time.

Again, exactly contrary to our practice with the Deglet Noor. Our third condition is that these blooms be pollinated just as soon after they open as possible. If they are exposed for even a day before pollinating, it is too long. It would probably be better to cut open the spath just before it naturally opens if we can so judge that time. Here again the Deglet Noor will probably go a week as easily as the Ashrasi 12 hours.

I mention this to impress upon you that each variety requires a different technique in the handling of the growing bunch. It is necessary that this be worked out in each case if we should grow a maximum crop of the best quality possible, and let me repeat again: Quality is the best salesman we can get to sell our California dates.

Bunch Management of Date Varieties Other Than Deglet Noor

By Robbins Russel, Manager Russel Brothers, Inc., Thermal, California

Supplementing the remarks of Mr. Leonhardt Swingle

LARGELY in the nature of a "postscript" to Mr. Swingle's excellent discussion, I present the following observations based particularly on the varieties Khadhrawi, Halawi and Barhi,—with due apology for their preliminary character and brevity,—they being based almost entirely on my personal experiences with these varieties in a single orchard.

It is perhaps unnecessary to state that the objective of all our effort is the production of the maximum of fruit of the most profitable commercial quality, at the minimum of expense. Therefore, practices which in a more technical sense might appear to be ideal, may prove to be incompatable with such a commerci l program.

Speaking generally, female date blooms of the various varieties I have had opportunity to check,

would appear to group themselves into three classes so far as their pollination is concerned. These may be described as:

First, Those readily pollinated. Examples most generally known are Deglet Noor, Halawi and Zahidi.

Second, Those on which a "good set" may usually be obtained, but which are distinctly more unreliable in this regard than the varieties of the first class. Examples are Khadhrawi and Barhi.

Third, Those having a high degree of selectivity as regards particular pollens and which would appear to be very difficult to pollinate for other causes also. The outstanding example is Ashrasi.

As Mr. Swingle has stated, varieties of the first class need occasion even the amateur grower no real anxiety as to the securing of a heavy "set" of fruit. If there are many males in the neighborhood and any wind blows during the flowering period, my experience indicates it is difficult to avoid such a result.

Mr. Swingle's remarks on the variety Ashrasi conform to my observations with one apparent variation to be commented on under my remarks on Khadhrawi and Barhi.

At this point may I call to your attention purely as information of interest and only possible commercial value, one rather striking similarity noted on our property as regards the varieties under observation. This is the likeness in the total number of fruit strands in the fruiting heads of the different varieties, as well as in the number of individual flowers borne on the individual strands. In illustration I mention the following actual counts of average, un-thinned fruiting heads:

Halawi—80 to 100 strands, 11 to 21 inches long: each carries 30 to 50 flowers.

Khadhrawi—80 to 100 strands, 11 to 21 inches long: each carries 30 to 50 flowers.

Barhi—80 to 100 strands, 13 to 28 inches long: each carries 30 to 50 flowers.

This would seem to indicate that the palms of many of the different varieties at least, supply about the same number of blooms per fruiting head. Therefore the difference in yield which undoubtedly exists as between varieties, would appear to be a function of the size of the individual berries,—the density of the fruit "set" obtained, and the number of sobata which the individual variety is capable of maturing.

Speaking strictly in the practical sense,—the one general rule which it seems to me is definitely established, is that on a mature palm, no sobata should be allowed to carry more fruit than it will bear without propping. This load figure would appear to be from 800 to 1,200 berries borne on from 40 to 70 fruit strands.

Our technic for attaining this load on the varieties mentioned as characteristic, follows:

First: The palms of both sexes are regularly dethorned every winter, after harvesting and when work is slack,—before blooming begins.

Second: From a larger number of males, nine have at present been selected, representative of four or five different "varieties." These regularly bloom, beginning before the first female opens in the spring and continuing throughout the season until late into April. As a result we are able to use fresh pollen almost exclusively. Our method is to cut the male bloom just as soon after the spathe begins to open as is possible. If not required at once, the bloom is removed from the spathe and hung upside down from the rafters in our tool shed, where it dries with a minimum of mould or other trouble.

Inasmuch as one of the characteristics used in selecting these males was absence of "shatter" and another, "retentability" of pollen (if I may employ the terms to illustrate my meaning), these male blooms remain in usable condition for weeks at the least,—though as a rule being used but seldom by us, as mentioned above.

It is perhaps interesting to observe that one of these very males has on occasion furnished ample material for the pollination of over 15,000 female blooms.

Third: Generally speaking, our pollinators cover the orchard three times per week. Since in practice, we pollinate all blooms which are open, or have definitely started to open, this results in the female spathes being open at most only a few hours before being pollinated.

Fourth: We do not thin at the time of pollination. Though unable to offer a satisfactory explanation why, experience here has indicated that if blooms of the Khadhrawi and Barhi type are cut at the time of pollination, either because of some shock, or for other reason,—a very poor fruit "set" is apt to be obtained. The possibility of this being a factor in the pollination of Ashrasi has not been thoroughly investigated either by me, or anyone else to my knowledge.

Another reason (strictly a cost factor) is that if all our pollinators thin at the same time, a much larger crew of more responsible and therefore more expensive men, has to be used.

It is also true that on the varieties mentioned, proper thinning at pollination time is rather difficult on many of the blooms,—due to their habit of opening before full emergence from behind the leaf base.

For these reasons, our men doing the pollination do nothing else during this time,—using one or two strands of the male blooms for each female, with a rubber band around the whole to assure the male flowers remaining in place for a period of at least ten days or so.

The instructions to these men are to pollinate all good blooms, irrespective of the number on the palm.

Fifth: Following this, — when the female blooms are from two weeks to a month old, our first thinning is given,—generally approximating the following changes from the figures mentioned formerly for un-thinned fruit heads of the same varieties:

Thinned Halawi (center cut out and ends removed)—40 to 60 strands, each from 13 to 17 inches long and carrying upwards of 20 flowers:

Thinned Khadhrawi (center cut out and ends removed) — 40 to 60 strands, each from 13 to 16 inches long and carrying upwards of 20 flowers:

Thinned Barhi (center cut out and ends removed) — 40 to 60 strands, each from 16 to 22 inches long and carrying upwards of 20 flowers.

Note: By "flowers" is meant properly pollinated individual blooms, capable of maturing perfect berries.

At this time each fruit head, after thinning, is tied with a loose running, cord loop, much as described by Mr. Swingle.

Sixth: As soon as possible, following the completion of pollination, all excess blooms are cut off. It seems to be rather definitely established that under the environmental conditions of our property, at least, Khadhrawi and Halawi palms, when mature, will readily carry all the sound bunches they produce in a normal year, — averaging in number from ten to fourteen. Barhi has been more variable with us and it is rather indicated that later experience may bring about the limiting of the number of bunches, more as is the custom with Deglet Noor,—thus assuring an even year by year

production. At present, however, our practice is as with the other varieties, — to leave all sound, well-formed bunches,—which may number as high as twenty per palm, though sixteen per palm would be nearer a yearly average.

Seventh: On or before this time, —before the fruit stalks have gotten so long in the case of varieties like the Barhi as to make it difficult to reach the fruit heads readily,—a secondary thinning is given, where necessary.

In the case of the Halawi there frequently is enough shatter to reduce the number of berries approximately to the 1,000 ideal. If so, this appears to be the best possible thinning. If there are still many more than this number of berries, our custom is to cut the center strands which hang from the fruit stalk, so that as much freedom for the growth of the inside fruit as is possible, will be allowed.

In the case of the Khadhrawi and the Barhi, the "set" may be (and many times is) sparse enough to give only the proper load of fruit. If so, the result is almost ideal. If it is not, additional strands in the center are cut much like the Halawi.

Eighth: Following the completion of these operations, as the fruit heads become heavier they gradually work themselves down through the leaves, with a certain amount of mechanical aid on our part.

Ninth: Mite damage, especially the last four years, has not been anything of a factor, even on our unsulphured Deglet Noor. The technic described by Mr. Swingle is undoubtedly advisable as a general rule, however, and may be adopted as standard even on our varieties,—as it is cheap insurance at the least.

Tenth: So far as the soft dates of the varieties mentioned go, bagging is almost exclusively a question of bird damage, versus darker dates, which can only be determined in the light of actual conditions on the individual properties. Even in our own case, while much experimental work has been done, I do not feel that I have any conclusions to offer as yet.

The Commercial Utilization of Differences in Time of Ripening of Dates Due to Pollen

By Roy W. Nixon, Associate Horticulturist, U. S. Department of Agriculture

THE results of the series of pollination experiments begun in 1925 at the U. S. Experimental Date Garden have been reported from time to time in the past. They have afforded ample proof that the time of ripening of dates, as well as the size of the fruit and seed, may be influenced directly by pollen. In nearly all of these experiments the pollens tested were applied to different strands on the same bunch. In none of them were the pollens used on a large scale in such a way as to provide a demonstration of the possible commercial utilization of the differences in time of ripening which they produce. In 1930 such an experiment on a commercial scale was made.

At the U. S. Experiment Date Garden five Deglet Noor palms were pollinated with dactylifera pollen (Fard seedling males) already known to produce early ripening of the fruit and five other comparable palms with dactylifera pollen ("Mosque seedling male) known to produce late ripening. These two pollens in numerous experiments in previous years have produced as much variation in the time of ripening as has yet been found among the many dactylifera males that have been tested.

With the cooperation of Mr. T. J. Gridley and Mr. William Cook similar tests were made in commercial gardens. At the Narbonne Ranch two Deglet Noor palms were pollinated with Fard and two with Narbonne, No. 1, a pollen comparable to Mosque. At the Cook Date Gardens in the Coachella Valley, at Indian Wells, California, two Deglet Noor palms were pollinated with Fard and two with Cook's No. 1, another pollen comparable to Mosque. In addition, on one palm the blooms during the first half of the season were pollinated with Fard and the remainder with Cook's No. 1, while on another palm the application of the pollens was reversed. This was done for the purpose of spreading out the ripening on the one hand and contracting it on the other. All of the blooms were bagged when pollinated and the bags left on from two to three weeks. Otherwise they were handled in the same way as the other palms in the gardens in question. It has been observed in past experiments that the bags themselves cause a slight acceleration of ripening, but as the pollinated bunches compared were all bagged in the same way this would not affect the differences which resulted from the use of different pollens.

In harvesting, the fruit from each palm was picked and weighed separately. From time to time representative samples of the dates produced by these pollens were carefully compared. No consistent differences were found in appearance, texture, or flavor. While the dates from the Fard pollen tended to be slightly smaller than the others, this did not hold true with all of the samples examined and the difference in size could hardly be regarded as of any commercial significance. In experiments in which these same pollens were applied to different strands on the same bunch there have been very significant differences in the size of the fruit. It appears that such differences tend to disappear when the pollens are applied on a large scale to entire palms, due probably to the effects of the rigorous thinning now generally practiced with the Deglet Noor variety. However, there were still striking differences in the seeds, those from the Fard pollen being noticeably smaller in every case, although the difference on a percentage basis was less than when the same pollens were applied to different strands on the same bunch.

The accompanying table summarizes month by month the total yield from each group of palms:

DIFFERENCES IN TIME OF RIPENING DUE TO POLLEN — 1930

Location and Pollen Used	Total Yield Pounds	SEPT. Pounds Picked	SEPT. % Crop	OCT. Pounds Picked	OCT. % Crop	NOV. Pounds Picked	NOV. % Crop	DEC. Pounds Picked	DEC. % Crop	JAN. Pounds Picked	JAN. % Crop
U. S. Experiment Date Garden											
"Fard" (5 palms)	1217.25	744.25	61.14	449.5	36.92	23.5	1.94				
"Mosque" (5 palms)	1270.00	347.75	27.38	674.25	53.09	241.0	18.98	7.0	0.45		
Narbonne Ranch											
"Fard" (2 palms)	317.5	125.5	39.52	185.5	58.43	6.5	2.05				
"Narbonne No. 1 (2 palms)	433.25	90.25	20.83	326.5	75.36	16.5	3.81				
Cook's Gardens											
"Fard" (2 palms)	623.5	199.75	32.04	367.25	58.90	54.5	8.74	2.0	0.32		
"Cook's No. 1" (2 palms)	921.0	86.75	9.43	327.00	35.50	391.75	42.53	94.50	10.26	21.0	2.28
"Fard"-"Cook's No. 1" (1 palm)	408.5	92.0	22.52	131.0	32.07	147.0	35.99	33.5	8.20	5.0	1.22
"Cook's No. 1"-"Fard" (1 palm)	329.0	33.5	10.18	168.75	51.29	116.25	35.34	10.5	3.19		

It is evident that the effect of pollen on the time of ripening of the fruit is not reduced by its application on a commercial scale. At the U. S. Experiment Date Garden the Fard pollinations ripened 61% of the fruit in September and the harvest was practically over by the first of November. On the other hand, the Mosque pollinations ripened 33% less of the crop in September and 17% more after November 1st.

At the Narbonne Ranch the Fard pollinations ripened 18% more of the crop in September than Narbonne's No. 1 with about an equal increase of the latter over the former in October, although the differences there were not so striking because of the short ripening season. The fact that the palms in question were in a row with a southern exposure may have had something to do with this, although the entire harvest at this ranch was completed earlier than in past seasons.

The Cook Date Gardens afforded the most striking contrast of all; 22% more of the crop from the Fard pollinations ripened in September and only 9% remained on November 1st, whereas 55% of the crop from Cook's No. 1 was harvested after November 1st and over 12% in December and January.

At the U. S. Experiment Date Garden and the Cook Date Gardens the fruit was picked regularly every week and from this data the differences in time of ripening were calculated. At the Indio station the actual difference in the time of ripening was 15 days at the beginning of the season, increasing to 20 days at 98% of the crop, whereas at the Cook Date Gardens there was a difference of 21 days at the beginning of the season, increasing to 37 days at 98%. This demonstrates on a commercial scale the fact already known from previous tests, that the differences in time of ripening due to pollen are less when the fruit ripens early and tend to increase when the season is late.

It is evident that for most locations in the Coachella Valley pollen which produces early ripening is not desirable for Deglet Noor dates. The fruit of this variety that matures here prior to about October 1st is generally characterized by poorer keeping quality and less distinctive flavor than fruit that matures during October and November. On the other hand the very late dates, that is fruit which ripens after about December 1st, are apt to be inferior to dates that ripen during October and November. The danger of damage from rain and humidity increases later in the season and low temperatures in December and January retard the ripening processes to such an extent that the fruit frequently does not mature properly.

The treatment at the Cook Date Gardens where late ripening pollen was applied to the early blooms and early ripening pollen to the late blooms on the same palm suggests a procedure that would be of value in such localities under conditions such as obtained in 1930. This Method resulted in speeding up the maturation of the fruit that would ordinarily have ripened after December 1st. Early ripening pollen on the early flowering bunches increased the percentage of dates ripening in September, which is undesirable, while late ripening pollen on late flowering bunches retarded the ripening of many dates into winter, which is also disadvantageous.

However, with varieties other than Deglet Noor or under diffferent climatic conditions an expansion of the ripening might be desirable. It would tend to decrease the amount of damage that a rain at any one time would produce, but would prolong the time during which protection from rain might be necessary. The grower, if in close touch with his packing house, can determine whether contracting or expanding the time of ripening of his crop one or two weeks will be of benefit. This can be accomplished at no extra expense by using properly selected pollen.

New Investigations on the Correlation Between Root and Leaf Growth and the Water Requirements of the Date Palm

By Walter T. Swingle, Principal Physiologist in Charge, Crop Physiology and Breeding Investigations, Horticultural Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

THE date palm is the only fruit tree cultivated in the United States that belongs to the great subkingdom of Monocotyledonous plants with a single seed leaf to which belong the grasses, lilies, orchids and many other plants.

Very few tree monocotyledons are found outside of the palm family. The most striking examples of true monocotyledonous trees other than palms are the tree yuccas, typified by the Joshua tree of the Mohave desert, and the Dragon tree, said to live a thousand years and attain a height of seventy feet and a circumference of thrirty-five feet in the Canary Islands, both belonging to the lily family; a relative of the centuary plant known to botanists as Fourcroya longaeva, native to Mexico and said to live four hundred years and attain a height of sixty feet before it blooms and dies (this plant belongs to the amaryllis family); and finally the screw-pines or pandanus of which numerous species grow in the tropical regions of the Old World, some of them reaching a height of fifty or even sixty feet, these belong to a special family, Pandanaceae. The other large monocotyledons, like bananas and plantains, the aroids and the bamboos are not true trees. Monocotyledonous trees such as the date palm are not only very distantly related to our common forest and orchard trees but are very different in anatomy, morphology and even in their physiology. Profoundly impressed with these many differences the late Mr. C. E. Cook, a great leader in the date industry of this country, attributed some of the difficulties date growers encountered in propagating and growing the date palm to the fact that the North European people had never had any experience with monocotyledonous trees. The date growers of this country are likely to have many opportunities to learn the truth of this observation of Mr. Cook's before the date palm and its peculiarities become as well known to us as, say, the apple tree or the orange tree!

The date growers of the upper Coachella Valley from Indio west have had excellent opportunity during the last twenty-five years to observe for themselves the surprising amount of water this tree demands. As the water table lies too low in most of this region to be reached effectively by the roots of the date Palm the date grower here is in a position to know exactly how much water he gives his palms. The results of this first-hand experience in growing the date palm have been most surprising and many of the best date growers in the Coachella Valley have come to use amounts of water in irrigation that seem out of all reason when compared with the water requirements of citrus trees in Orange or San Diego counties for example. In some cases as many acre feet of water are used on date palms in the western end of Coachella Valley as acre inches are used for citrus in northern San Diego county. (See Beckett, Blaney & Taylor, Bull. 489, Cal. Ag. Exp. Sta., 1930). In Orange county 16-18 acre inches was found ample, "and the use of twenty acre inches had a depressing effect on the yield." (An. Rep. Cal. Ag. Exp. Sta. 1929, p. 81-82).

Such a striking contrast in the duty of water has not failed to attract widespread attention and there is every reason to hope for the help of Mr. S. H. Beckett and other experts of the Citrus Experiment Station at Riverside and let us hope of the experts of the newly established Bureau of Agricultural Engineering of the U. S. Department of Agriculture who cooperated with Mr. Beckett in the study of the water requirements of citrus reported on in Bulletin 489 of the California Agricultural Experiment Station. Work by such experts in cooperation with the leading date growers cannot fail to yield important results of great value to the young and rapidly growing date industry.

Paradoxical as it may seem the date palm is in many ways like a swamp plant—the germinating seedlings are plainly adapted to grow in very wet situations and even have special organs to excrete superfluous moisture. Special aerating roots, commonly called breather roots by the date growers, grow directly upward out of the ground around the base of the trunk especially in the Deglet Noor variety and these roots, like the aerating roots of the mangrove and other swamp plants, have special structural adaptations to facilitate the entrance of air through porous tissues formed near the tips.

An expressive Arab proverb says, "The date palm grows best with its feet in running water and its head in the fires of heaven."

Milne in his beautiful book, "The Date Palm and Its Cultivation in the Punjab" (2 ed., Calcutta, 1918), gives a full-page plate showing two date palms still living in a pool of water in spite of the fact that their bases had been covered continuously with water for the preceding six years. The crowns had suffered and the roots were considerably decayed but one of the palms still had a dozen or more green leaves besides about as many that had died and bent down against the trunk.

In connection with studies that have been under way for some years past looking to the working out of a cheap and practicable system of replacement of date palms when they get too tall to handle easily or too old to bear full crops it has become very apparent that the water requirement of the date palm can be modified greatly by removing leaves from the crown.

Severely pruned Deglet Noor palms at the U. S. Experiment Date

Garden have for four years continued to bear large crops of fruit though of a somewhat smaller quantity and of a somewhat lower grade than that produced on check palms nearby which retained the full crown of leaves. In date-growing countries the tops of the palms are often severely pruned as can be seen clearly in photographs taken in Old World date oases.

Evidence has also accumulated as to the very different character of the root system of the date palm from that of any other fruit tree grown in temperate or sub-tropical regions. The main roots show no secondary growth and in consequence are never larger than the finger—no matter how long they may grow. Because of this structure, fundamentally different from the roots of ordinary dicotyledonous trees, the roots of the date palm are exposed to dangers that do not threaten those of ordinary fruit trees. If the subsoil should remain dry for a few months or possibly even for a few weeks it is highly probable that some or all of the very long main roots are caused to die back clear to the bulb at the base of the trunk where new roots arise. It must be remembered that it takes a long time, a number of years in fact, for new roots to grow to the length of the old ones that have been killed by temporary failure to get sufficient irrigation water so that if the palm retains its full crown of leaves it usually cannot secure enough water through its diminished root system even if abundantly irrigated and soon shows distress by the sudden death and drying up of the older leaves.

Many facts observed in recent years make it highly probable that date palms have, in fact, often suffered acute water shortage for longer or shorter periods in date gardens that were supposed to be receiving the best possible care. As can be seen from what has been stated above it is likely that a water shortage, even a temporary one, may cause injuries to the date palm much more severe than would be caused to any ordinary fruit tree, the thick roots of which, even if the tips die, can regenerate innumerable new adventive roots as soon as water is available again.

Probably no other fruit tree grown in this country is so sensitive to sudden changes in the method of irrigating. If a widely extended root system is encouraged to develop by frequent light irrigations it runs grave risk of injury if the irrigation water is suddenly applied in much larger amounts at much longer intervals. If the soil is light such a system of irrigation tends to flood the soil at every irrigation and then to permit it to become dangerously dry before the next irrigation.

Naturally the discussion above refers primarily to date palms grown on land having the water table too low to furnish an adequate supply of water. With a high water table, conditions are changed and often aeration becomes even more important than irrigation.

Finally the different date varieties have very different reactions to water at the ripening period. The crop of Deglet Noor, Saidy and many other varieties is easily injured by excessive irrigation just as the fruit begins to ripen while the Halawy and probably many other varieties do not ripen their fruit properly unless the soil is kept wet and the air humid during the ripening season. This fact makes it difficult, if not impossible, to test different date varieties fairly unless they are planted in separate borders and each variety given the treatment best suited to it.

It also appears probable that some date varieties are robbed by others if planted close to them. This is rendered possible by the widespreading habits of the date roots. Certainly date varieties differ greatly in vigor, rate of growth, and fruitfulness as well as in the types of soil to which they are adapted, and the amount of fertilizer they require.

There is a well nigh universal belief among the Arab date growers of the Old World that offshoots are better and more likely to grow when cut from palms that have been only moderately or even scantily irrigated. Many facts indicate that this belief of the Arabs is well founded and that if good viable offshoots are desired the irrigation must be moderate in order to prevent the growth of soft and sappy offshoots that fall an easy prey to the Diplodia fungus studied by Drs. Fawcett and Klotz and possibly to other organisms causing decay and death.

The water needs of the leading date varieties need to be studied at all stages of development from the planting out of offshoots or young palms through the offshoot-bearing period into the heaviest fruiting period and finally into and through the replacement period. Each of these periods doubtless requires somewhat different watering to get the best results.

In order to assist the date growers in getting ample and convincing evidence as to the water needs of the leading date varieties at all stages of their growth a series of experiments is now being initiated at the U. S. Experiment Date Garden at Indio, California. In these experiments it is hoped that some things the date growers would not willingly do himself can be done.

For instance, an attempt to grow half or quarter-acre plots of date palms with what is now considered far too little water, and other plots with what is now believed to be too much water, both in comparison with what is now generally considered to be a proper amount of water. As a staff is on the station grounds the year around and very full meteorological records are kept it is hoped that some plots can be irrigated by formulas based on the water content and the temperature of the soil and air. Finally, it is hoped to make deliberately sudden changes in the water regime and even in some cases to withhold water for some months in order to learn how best to bring date palms injured by such treatment back to normal. Although some date growers by accident or oversight have doubtless occasionally injured palms by such treatment no private date grower would willingly permit a quarter or half-acre block of his palms to be ill treated just to see how much damage would be done and how best to repair it.

These irrigation experiments fit in very well with acreage plantings that are necessary to make proper tests of different systems of renewal, a matter now often considered to be of merely theoretical interest but which will, not many years hence, be an acutely practical and pressing one to the owners of the older date plantings in this country. Very special conditions apply to the water requirements of a date garden during the renewal period when both old and young palms are being grown on the same tract at the same time. Here again the U. S. Experiment Date Garden can and should undertake experiments that the date grower would hesitate to make, and test not only what now seem to be the best renewal systems but all that have any reasonable hope of succeeding.

Although the date palm has probably been grown longer than any other fruit tree—at least five thousand years—the scientific study of it was begun only recently and al-

though very gratifying progress has been made by expert American date growers and by state and federal research men we must not forget that an enormous amount of work remains to be done before the date palm is as well understood as the orange tree or the apple tree. In spite of centuries of experience and of scientific study, numerous skilled research men are still at work in many countries on these two fruit trees which are grown by hundreds of thousands if not millions of intelligent and observant orchardists. Discoveries of great scientific and practical importance are still being made about these fundamentally important fruit trees and will doubtless continue to be made for many decades to come.

In the case of the date palm we are dealing with a monocotyledonous tree of radically different structure and habits from our familiar orchard trees. We should all of us do everything in our power to encourage scientific research and expert demonstration work to put our knowledge of the date palm and its cultural requirements on a par with that existing for the orange and the apple tree. Here is work for scores of experts for many decades and here is a fascinating field for the ingenuity and resourcefulness of our date growers who have already in two decades equalled in many fields and surpassed in some the attainment made by the Arabs—the masters of desert agriculture—during the past two thousand years.

Sterilization of Soils With Formalin

By Frank A. Thackery, Senior Agriculturist, U. S. Department of Agriculture

I SHALL attempt in this paper to give you only a brief description of an attempt to eradicate a fungus, Phymatotrichum omnivorum, commonly known as Texas root rot, from approximately five acres of land by the injection of formalin under high pressure into the soil.

I wish first to acknowledge the cordial and effective cooperation in this campaign of the State officials and the Farm Bureau of this Valley.

The pictures which I am passing around will make it easier for you to understand the story I am trying to tell you.

As most of you know, formalin is an aqueous solution of formaldehyde, usually having in its commercial form a strength of about 40%. Formaldehyde is a gaseous compound, H-CHO, with a very penetrating odor and is most commonly formed by the partial combustion of Methyl or wood alcohol. Aldehyde is an abbreviation from alcohol dehydrogenatum and, as the latter name indicates, it is alcohol deprived of its hydrogen. It may be any one of a class of compounds of which common or acetic aldehyde is the type. They are usually named from the acid which they yield on oxadation. Thus formaldehyde yields formic acid.

The aldehydes are intermediate between the alcohols and acids and differ from the alcohols in having two less hydrogen atoms in the molecule.

The Texas root rot is very destructive to a wide range of plants and in our case was made much more difficult of eradication from the fact that the entire infested area had been used for experimental tree plantings such as fig, almond, date, olive, jujube, pistache, apricot, peach, athel, etc. In addition to this, four permanent buildings and a cement tennis court were located on the tract and it was necessary to treat the soil to a depth of six feet under these structures. Therefore, our expenses were much higher than would usually be the case.

After careful consideration of various possible methods of eradication the formalin treatment was decided upon by Dr. K. F. Kellerman, Associate Chief of the Bureau of Plant Industry. Laboratory and field tests on a small scale had been worked out by Mr. C. J. King of the U. S. Experiment Station at Sacaton, Arizona, which tests indicated the effectiveness of the formalin treatment.

In addition to this, many more or less preliminary tests were made at our station, among which may be mentioned the treatment of a two-foot strip of soil along our north boundary for the purpose of checking any spread of the fungus onto neighboring lands. A seedling date palm, some eight or ten years old, was located about eight feet from this two-foot strip of treated ground. This treatment was to a depth of six feet with a 1¼ per cent formalin solution which was injected at the rate of approximately one gallon per cubic foot of soil. Between the seedling date palm and the treated strip was a tar barrier four inches in diameter by four feet in depth, through which little or none of the solution would be expected to penetrate. The treatment of this two-foot strip, however, killed the seedling date palm within about twenty-two days after treatment.

The soil underneath and about three feet beyond the spread of the branches of an apparently healthy pistache tree, which was seemingly resistant to root rot, was treated experimentally. The same 1¼ per cent solution was used and the injections were to a depth of six feet but only one injection each two feet instead of every foot as was the case with the regular field treatment. This experimental treatment amounted to only one-fourth gallon of formalin solution per cubic foot of soil, whereas, the regular field treatment was one gallon per cubic foot. This tree wilted and died the fifth day after treatment and on examination that day the cambium layer was found to have turned black.

The soil under a citrus tree, an olive tree, and another species of pistache tree was given the regular field treatment and in each case the tree died within four or five days thereafter. A Chinese umbrella tree given 1-9 of the regular field treatment showed little if any distress, from which it would appear that most plants would have been killed with a much weaker formalin solution.

We first attempted the injection of formalin into the soil prior to the removal of the trees from the infested area. Many of these trees were from one to two feet in diameter and it was soon found that their large roots seriously interferred with an even injection of the solution, besides greatly retarding the work. The treatment, therefore, was

suspended until all trees were removed through the use of a caterpillar tractor and by hand labor. Where the trees were too firmly established to be pulled by the tractor enough of the large roots were cut to enable the tractor to pull the trees, and later the large roots were pulled one at a time by the tractor. By this method it was intended to remove from the soil every possible portion of the host root constituting the principal food supply of the fungus.

Later experiments indicated that there might have been some benefits in treating the soil, in spite of the difficulties mentioned, while the trees were still alive. The infested soil had not been irrigated for about three years and consequently was very dry. The treatment was accomplished in April, May, and June, and the roots of a few trees left for experimental treatment and observation appeared to rapidly absorb the poisonous formalin solution and it may be that a better penetration of the poison into the roots would have resulted from the live roots.

The formalin was injected into each square foot of the entire five acres to a depth of six feet under a pressure of about two hundred pounds per square inch and at the rate of one gallon per cubic foot of soil. The pressure was procured through the use of ordinary orchard spray rigs equipped with a special pipe and nozzle. Two of these spray rigs were located within a few feet of each other and made stationary at a convenient place on the area to be treated. A mixing tank, with a capacity of approximately one thousand gallons, was placed between the two spray rigs on a temporary tower made of empty barrels, the height being only sufficient to run the formalin by gravity from the mixing tank to the spray rigs close by.

A temporary three-inch pipe-line was installed to convey the necessary large amount of water from our domestic supply tank to the mixing tank. This very greatly facilitated the delivery of water since it required 251.360 gallons per acre for this treatment.

The solution injected into the soil consisted of 1¼ per cent commercial formalin and 98¾ per cent water. We made many preliminary tests to ascertain the amount of solution required per cubic foot of soil to secure complete penetration. This was accomplished by constructing a number of boxes containing, when full, an exact cubic foot of soil. By weighing the empty box and later the box filled with dry soil, then with soil of various degrees of moisture content up to complete saturation, we were able to determine the amount of solution per cubic foot required for thorough penetration.

The mixing tank was properly leveled and a line made about two inches from the top of the tank, up to which line the tank was each time filled with water. Knowing the exact capacity of the tank, the 1¼ per cent formalin was added as the tank was being filled so that the water running into the tank from the large three-inch supply pipe gave it a thorough mixing. As the solution was conveyed by pipe from the mixing tank into the spray rig tanks it passed through a very fine copper wire screen to prevent any obstacles from clogging the nozzles at the lower end of the injecting pipes.

In order to avoid moving the spray rigs, the mixing tanks, and the large water supply pipe, we connected the discharge pipes of the two spray rigs with a single pipe of proper size, running this pipe to any desired location, and from the end of the pipe the formalin was conveyed through high pressure rubber hose to the place of operation.

One of the large spray rigs will pump under high pressure about thirty-six gallons per minute. We had three high pressure hose connections on each spray rig with two injectors on each hose, — one man being required for each pair of injectors. These injectors consisted of two ⅜-inch common pipe six feet in length, the same being connected one foot apart at the top with ordinary pipe connections consisting of two ⅜-inch ells, two nipples, and a tee in the center, to which the high pressure hose was connected, a quick or lever shut-off valve being installed between the tee and the high pressure hose where it would be handy to the operator so that he could shut off the flow of the formalin solution while changing from one injection to the next.

On the lower ends of these injecting pipes were attached especially made steel nozzles about two inches in length with ⅜-inch pipe thread at one end, the other end tapering to a point like a sharpened pencil. About one-half inch from the small or sharp end of the nozzle were eight 1-32 inch holes through which the formalin solution was forced in a horizontal direction as the injectors went perpendicularly into the soil to a depth of six feet and back. Each injection required approximately one minute, the treatment covering the soil for six inches in all directions from the injecting pipe, thus treating approximately six cubic feet of soil per injection or twelve cubic feet per man with his pair of injectors. In the end of the injecting nozzle were two additional 1-16 inch holes pointing at a slight outward angle rather than straight down. The formalin forced through these two holes aided materially in cutting the way through the soil for the injecting pipes. In fact, with the weight of the two six foot pipes and the connections mentioned, the injectors moved downward at about the right speed and without other aid. It should be noted here that our soil is of a loose sandy type.

In order to have the injections uniform and regular, one injection for each square foot of surface, we constructed several platforms using common 2x4 dimensions for the cross pieces and common ¾-inch 1x12 boards for the platform. We bored one-inch holes exactly one foot apart over this entire platform, the platforms used by us having six holes across by sixteen in length or a total of ninety-six injecting holes per platform. The surface of the soil was smoothed off before placing the platform and then the soil was banked up slightly around the entire outer edge of the platform to prevent the solution forced up around the outside of the injecting pipes from leaving the soil actually under treatment.

We tried water meters on the discharge pipes of the spray rigs but they were not satisfactory because we had three men, with two injectors each, working from each spray rig and one of the men was frequently delayed by the injecting pipes striking a root or other similar obstacle hidden in the soil. We were not able to find any meter on the market suitable for attachment to each injector. We were able, however, to keep a very close check on the amount of formalin per injection. Each platform, as stated, having ninety-six injecting holes, made it easy to keep an exact count of the injections per hour or per day. Each mixing tank contained an exact number of gallons of formalin so we could check any time on the amount of formalin per injection. To be safe, we kept slightly above one gallon per cubic foot of soil or six gallons per injection.

For a part of the time we kept

two large and two small spray rigs going and when all went well we could make about 5,300 injections per day, requiring 31,800 gallons of the formalin solution.

Our injections proper started on March 14th and the five-acre tract was finished June 5th with the exception of a small amount of soil under the cement tennis court for which it was necessary to construct special equipment. Treatment of the soil under the houses and the tennis court was accomplished by boring or drilling holes in each square foot of the entire floor space through which to make the injections. In the case of the cement tennis court we were able to inject the solution for some distance under the cement from around the outside by holding injecting pipes of extra length at various angles to cover the depth of soil treatment desired.

On one portion of the infested area it was necessary to treat the soil within about ten feet, but only on one side, of a row of citrus trees. Most of the trees showed wilting and heavy shedding of the foliage from about the fourth or fifth day after treatment. In many cases about one-half of the tree died and the other half lived. The dead portion of the tree being always the side nearest the treated soil.

It was necessary on another part of the infested area to treat within about ten feet, also on one side only, of seven twenty-year old and three ten-year old date palms. All of the palms showed wilt about the fifth day after treatment. Six of the seven large palms were killed outright and the seventh, while still living, was seriously damaged by the treatment. The three young palms, however, were not seriously hurt due most likely to the fact that the root system of the young palms had much less spread than that of the old palms and consequently received less of the formalin. It was noted that all palms seriously hurt by the treatment first showed the formation of many drops of a sticky sweet substance on the base of the leaf stems.

Practically all weed seed within the treated area appears to have been killed by the treatment. Pure cultures of the root rot fungus were planted in the soil of the infested area ahead of the treatment by Mr. C. J. King. These were taken up for examination at various intervals after treatment and some of them, on the largest roots, had not yet been killed. The soil where these pure cultures were planted was later given double strength treatment. Many roots showing old infection have been taken from the treated area at various intervals but so far no live fungus has been found.

About thirty days ago Mr. King and Mr. H. F. Loomis found a considerable number of the sclerotial form of the fungus in the treated area but after careful tests these proved to be dead. At the same time they also found this form of the fungus at the Indian Wells infestation and under the same tests those from Indian Wells showed plenty of life.

Last season we planted several rows of cotton around the treated area, but just outside of it, to determine if we had treated all of the infested area. Cotton is one of the most susceptible plants to this fungus. After these cotton plants had grown the entire season and were about to be killed by frost we had each plant pulled separately by hand and the roots carefully examined. They all showed clean roots with the exception of three spots on the Robert Barker land north of the Experiment Station and on untreated land. These three infestations contained approximately one square yard each. In each of these three cases there was four to five feet of clean uninfested soil on untreated ground between the infestations and the treated soil, indicating clearly that the treatment had been effective about four feet beyond the treatment. We have since treated another strip of land on the Barker place, the treatment extending about fifteen feet beyond any known infestation.

The treated soil has thus far been kept dry and free of plants of every description. In digging for roots and sclerotia in the treated soil some ten months after treatment we found the soil still very moist, due largely no doubt to the fact that there had been no plant roots in the area to draw the moisture out.

The cost of the formalin alone, most of it purchased in carload lots, for our job was $14,103.18 and with our high labor cost incident to the trees and buildings on the tract, the cost per acre was close to $3,500.00.

Although such cost per acre is prohibitive under ordinary circumstances it becomes entirely practical if you keep a very close watch for the appearance of the fungus and eradicate it while you have but a small spot. Formalin can now be purchased by the barrel for about 70 cents per gallon or $45.00 per barrel. Twenty-one gallons properly applied will thoroughly sterilize one square rod of soil to a depth of six feet and you should be able to detect the fungus before it has spread over a square rod.

Should you notice any circular spots of dead plants of any kind they should be promptly examined to determine the source of the trouble. This fungus is native in Texas, New Mexico and Arizona and most likely along the Colorado river in California. It is possible that it may be native in some of the moist shaded canyons emptying into the Coachella Valley.

Report of Progress---Date Scale Eradication

By B. L. Boyden, Senior Entomologist, Plant Quarantine and Control, U. S. Experiment Station, Indio, California

MOST of you are familiar with the early history of Parlatoria Date Scale eradication and know the scale, if not personally, by reputation, so I will deal briefly with this phase of the question and more at length on the methods used and progress which has been made since 1927.

The Parlatoria Scale is a very small insect which infests the foliage and fruit of the date palm. When first hatched the young have legs but no wings and crawl around for a short time, probably not more than two or three days. Finally they insert their beaks into the palm, and the females remain stationary for the remainder of their lives, the males until they mature. Upon reaching maturity the males emerge from their old skins, mate, and die. The soft body of the female has a protective covering which is developed as the insect grows. When the female is fertilized it lays eggs which hatch under the protective covering and then the young emerge for their brief active period.

This insect was introduced on offshoot importations from the Old World and was early recognized in this country as a serious pest. Attempts were made to control, and later to eradicate the insect in Arizona and later in California and considerable progress was made.

Late in 1927 a number of new infestations, involving a large number of commercial palms, were found and an appeal to Congress by those interested in the date industry resulted in an emergency appropriation of $25,000. With the additional funds a hasty survey was made of the entire date growing area. It was found that there were approximately 140,000 date palms in the Coachella Valley; 42,000 in the Salt River Valley; 32,000 in the Imperial Valley; 20,000 in the vicinity of Yuma; a few thousand in the Rio Grande Valley in Texas, also small non-commercial plantings at various places in the Southwest outside the areas mentioned above.

In the Coachella Valley there were numerous commercial plantings and also a large number of abandoned seedling plantings, many of them difficult, and some impossible to inspect properly. Several infestations, severe enough to be classed as centers of spread, were found at various points in the Valley from Mecca to Indio.

In Imperial county most of the palms were in small ornamental or neglected plantings, although there were a few commercial gardens. The scale was found to be rather generally distributed over the southern part of the county but none was found in the northern part. In Arizona conditions were similar to those in Imperial county but there was a much larger percentage of commercial palms and much less scale. Very few palms of standard varieties were found in Texas and no Parlatoria scale.

From a study of the reports of past work and field observations the following points seemed evident:

(1) That the Parlatoria scale was a serious pest of the date palm in the date growing area of the United States.

(2) That control would be difficult and expensive.

(3) That the scale could be eradicated from individual palms.

(4) That careful inspection would locate infested palms before the infestation had reached a point where spread was liable.

(5) That the known hosts of the Parlatoria scale in the date growing areas were the date and closely allied palms, the ordinary fan palm not included.

With this information at hand a program was laid out and the cost estimated. This was submitted to the Date Growers' Pest Control Committee and the Federal and State Agricultural authorities. The program was approved and the needed funds were promptly obtained.

From the reports turned in during the survey of the Coachella Valley the date plantings were all mapped. Each planting, whether it consisted of 1 palm or 1,000 palms, was listed and located on a large map of the Coachella Valley. An infested area was established, including all plantings which were considered to be within the range of natural spread from known centers of infestation. This infested area was divided into seven districts for convenience in inspection, report-filing, and charting.

The plantings were also classified for either scout or routine inspection. The terms scout and routine are here used to differentiate between the small plantings, which are inspected by men working in pairs, and the larger plantings which are inspected by larger groups of inspectors.

During the last six months of 1928, due to limited funds only 12 inspectors were available. One man was detailed to continue the survey in Arizona, one in the Imperial Valley, and the remaining 10 confined their efforts to the known infested properties in the Coachella Valley.

With additional funds available in January, 1929, the inspection force was increased and more work was done outside the infested gardens. It was not until July 1, 1929, when the increased Federal and State funds were available, that we had an adequate force in the field. At that time a careful leaf-by-leaf inspection of the Valley, with the exception of the Indian Wells district, was begun and was completed about the end of the year. A number of new infestations were found during this inspection but none outside the infested area.

In 1930 all plantings in the infested districts were inspected at least twice, some as many as six times. The number of inspections given a garden was determined by the location of the planting in regard to infestations and the conditions within the planting. Also all the plantings outside the infested area, except those in the High School district, were inspected.

The three fundamental operations in the Parlatoria eradication work are: scouting to locate all date palms, inspection to locate the infested palms, and treatment to eradicate the scale on palms found infested. The first survey located most of the palms in the Valley but the inspectors, especially the scout inspectors, were instructed to keep continually on the alert for unlisted palms and report any found. The list of commercial gardens was, of course, soon complete but small plantings and single palms, usually on abandoned

farms, were added to the lists from time to time. In 1930 inspectors were sent out to scout certain districts, doing no inspection except when unlisted palms were found. Early this year two men were started on a section-by-section survey of the Valley, beginning in the center of the infested area and working out. The men locate the corners of a section and walk over the entire area and turn in a report giving a description of the land, whether under cultivation now or in the past, and if not now under cultivation, the condition as to desert growth. Some sections are easily scouted and there is no chance of missing abandoned palms, others, because of the dense growth of desert brush, are not easily scouted and will be rechecked. About 30 sections have been checked to date and the work will be continued until the entire area is covered. Locating all ornamental date palms in the towns and cities is a phase of this work which requires considerable time. In the city of Indio, for example, there were over 300 date palms within the city limits in 1928 and at each inspection the inspectors had to go from lot to lot, up and down each street and alley. Naturally some palms were missed. As soon as time permitted after the first inspection, the palms were listed as to Block and Lot number and owner's name. On each following inspection the reports were checked with the list so that none would be missed and newly found palms added. New lists were made after each inspection.

In the eradication work the individual palm, rather than a block of palms, is taken as a unit. This is due to a number of reasons, the high value of the individual palm, the drastic treatment used, and the possibility of locating infested palms before there is any dissemination. Therefore, very careful inspection is necessary and this phase of the work takes most of the funds allotted to the project. In 1928 inspection was much faster than it is now as we had to cover a large area in a short time with fewer inspectors than we have at present. As the work progressed, however, inspection became increasingly more intensive as we were able to delineate the infested area more accurately, many of the palms difficult to inspect had been destroyed, the number of trained inspectors had increased, and our methods were more efficient, due to increased information.

We have in the office a chart of each district. On this chart each planting in the district is listed with the number of palms classified as to age and whether seedling or standard variety, the dates of inspections for the past two years, and, if infested, the number of infested palms found at each inspection. At the first of each month the work is laid out for that month and the squad leaders and scout inspectors are given lists from time to time of the properties to be inspected. When the inspection of a planting is completed the field man responsible turns in a report on a regular form giving the information required; number of palms inspected, number infested, source of new planting, if any, type of inspection (tower work, ladder work, and ground work), and the general condition of the garden as regards inspection (well pruned, bushy with offshoots, etc.), weather conditions, especially wind interference, and the number of one-man-days required for the inspection. The charts are kept up to date as the reports come in and inspection is laid out on the basis of this information.

In addition to the reports mentioned, records are kept on the routine inspection of infested gardens, giving the rows inspected by the various men. The gardens are inspected frequently and never twice in succession by the same crew. When an infested palm is found our records will show who inspected it previously and the information given to the inspectors. In checking over the inspection in infested gardens last year few infested palms were found which could reasonably have been expected to have been found on the previous inspection.

The standard method of treatment is defoliation and torching. All the leaves are cut off leaving only the protected bud undisturbed, the fiber is cut back to uncover all scale on the leaf bases and the flame of a gasoline torch is passed over the surface to kill the scale. If the palm is in bearing, this causes the loss of fruit for about two and a half years. In many cases, however, the infestation is so light that cutting off a round or two of leaves will clean up the palm with no apparent loss of fruit. If the palm is of no particular value to the owner, it is dug out and destroyed.

I have mentioned that the ordinary fan palm was not considered a host of the Parlatoria scale. Parlatoria scale has been found on fan palms many times when located near heavily infested date palms but the indications were that the natural mortality of the scale on the fan palm was greater than the increase and, if the source of infestation were removed, the scale would eventually die out. At the same time no chances were taken and all palms in the immediate vicinity of infested date palms were given casual inspection. As the work progressed and more time was available, more attention was given to fan palms and other possible hosts. In two instances in 1930 fan palms were found in Arizona heavily infested with Parlatoria scale and in both cases it was evident that the scale had bred up on the fan palms although the scale had come originally from date palms. These were small, young palms and the larger and older fan palms in the vicinity showed no scale. In the Coachella Valley an inspection of fan palms in the vicinity of date palm plantings heavily infested in the past few years was begun in September of last year; 2,543 fan palms were inspected and 44 were found to be slightly infested. The infested palms were all within a radius of 300 feet from a heavily infested date palm which had been overlooked by the scout inspectors.

During the first survey of the Coachella Valley thousands of seedling palms of no commercial value were located in the infested area. Some of these were in orchard formation, others in unthinned nursery rows; many were overgrown with mesquite and desert brush and weeds. Some of these plantings had been found infested and it was a certainty that others would be found infested later. Using ordinary methods it would be a long expensive task to clean up those infested. These plantings also could not be inspected properly and, if an infestation were present, it would probably develop to a point where spread to commercial gardens would be almost certain before the infestation could be located. Therefore, as soon as money was available in 1929 we began digging out and destroying these worthless plantings as soon as we could get the owner's consent. In some cases the entire plantings were dug out, in others a few were left for ornamentals. This has continued to date and we still have a few palms of no value which we would like to remove and probably will later. During the past three years we have dug out and destroyed 17,924 valueless palms from infested plantings and 23,948 in the infested area from plantings not found infested.

The results obtained are indicated

by the number of infested palms and number of infested properties found from year to year. In 1928, 1,592 infested palms were found on 22 properties, 6 new infestations; in 1929, 588 infested palms were found on 32 infested properties, 17 new infestations; in 1930, 186 infested palms were found on 20 infested properties, 5 new infestations. Fourteen infested palms have been found during the first quarter of this year as compared with 74 in 1930 for the same period. Only one of the 14 was a commercial palm which had to be treated. One was in a commercial garden but only a single dead scale was located. The remaining 12 were palms of no commercial value which were dug out. Beginning with July 1, 1929, when we first put a full crew of experienced inspectors in the field the number of infested palms found by quarters reads as follows: 104-266-74-50-36-26-14. No new infestation has been found since May, 1930. In the Imperial Valley and in Arizona the same procedure was followed. In those areas, however, there is much less routine and considerably more scouting inspection. In the Imperial Valley 1,064 palms were found infested during 1928, 165 in 1929, and 89 in 1930. In Arizona 41 infested palms were found in 1928, 50 in 1929, and 18 in 1930. The number of fan palms found infested are not included in the figures given.

While conditions look very favorable at present, we still have considerable work to do. We are not yet sure that we have located all infestations resulting from past heavy infestations and we will undoubtedly find more infested palms in the gardens now considered infested. We must continue for some time the search for palms which may have been overlooked. Inspection, especially leaf-base inspection, must be continued for some time in gardens which have shown scale within recent years.

However, I do not believe that we will find many more infested palms and eventually the scale will be eradicated.

SUMMARY OF DATE PLANTINGS IN THE COACHELLA VALLEY — APRIL, 1931

Commercial

Standard variety, 5 yrs. or over	34,090
Seedlings, 5 yrs. or over	6,663
Total palms 5 yrs. or over	40,753
Standard variety, 1 to 4 yrs. old in field	55,020
Seedlings, 1 to 4 yrs. old in field	4,087
Total palms 1 to 4 yrs. old in field	59,107
Standard variety offshoots in nursery	19,878
Seedling offshoots in nursery	191
Total offshoots in nursery	20,069
Total palms in field	99,860
Total offshoots in nursery	20,069
Total commercial palms	119,929

Non-Commercial

Ornamental date palms	3,636
Date palms, abandoned	24,628
Total non-commercial date palms	28,264
Total date palms in Valley	148,193

Investigations on Date Palm Diseases

By Dr. L. J. Klotz, Associate Plant Pathologist, Citrus Experiment Station, Riverside, California

A RESUME of our knowledge of date palm diseases was reported at the 1930 Institute. It seems desirable to present to this Institute a summarizing record of the results Dr. Fawcett and I have obtained on date palm pathology during the past year. Dr. Haas of the Department of Plant Physiology has continued to cooperate with us in the studies on decline and blacknose. At this point I wish to thank all connected with the industry who have cooperated and helped us so generously in this work.

Decline Disease

The discussion should most properly begin with the so-called "decline disease," probably the most serious trouble found in the Valley. In the Seventh Annual Report of the Date Growers' Institute, page 9, and in a current issue of Hilgardia, published by the University of California, the malady is described as being characterized by a retardation and eventual cessation of growth, destruction of roots, and a gradual reduction in the quantity and quality of the fruit produced until the palm is completely unfruitful.

On many occasions we have examined and compared roots of healthy and diseased palms. It is difficult to find healthy white roots under decline-diseased palms. Most of the roots are brown, soggy and disintegrating, and some of the rootlets have blackened tips.

In water cultures of date seedlings, as shown in the lantern slides, the effect of withholding potash and increasing calcium is a shortened, stubby root system having very short laterals with blackened tips. Paralleling this observation Professor Hibbard of the University has shown in a comparative study of soils bearing healthy and diseased palms that the latter have a greater capacity for fixing potash than do the former. Similar work is being continued with a large number of soil samples taken at one foot intervals to a depth of five feet.

As Dr. Haas pointed out last year, the pinnae and fruit from decline diseased palms are very deficient in potash as compared with those from healthy palms. Each harvest removes vast amounts of this nutrient, a crop from a single palm of 200 pounds of dates containing about 1½ pounds of potash (K_2O). Likewise the loss each year due to pruning and removal of outer whorl of old leaves must be considerable. It is evident that a palm in soil having a great avidity for fixing potash must experience great difficulty in securing potash sufficient for growth and crop production. From

this one might reason that the malady can be overcome by applying fertilizers containing large amounts of potash. However, extremely large quantities may be required to satisfy this avaricious fixing power before it is possible to increase the amount of potassium in the soil solution and provide for absorption by the roots. In addition the condition is made more serious by the deterioration of much of the root system under the conditions of decline, and, because a new growth of roots must be produced before rapid absorption is possible, one must expect the recovery to be slow.

Experience with the decline disease of prunes in northern California indicates that commercially it may be economically impossible to add sufficient potash to overcome such a condition. Our experiments with various fertilizers, amendments and chemicals now under way should eventually throw light on the question whether or not it is thus possible to induce recovery from decline. Trials are being made in five different gardens in the Valley, and it is hoped that before the next Institute there may be some definite results to report.

Soil applications of copper sulfate continue to show promise. Quantities up to 75 pounds disked into the circular area (750 sq. ft.) surrounding each palm, then followed by basin irrigation have shown indications of beneficial effects. Each of two palms was given an application of 125 pounds of the compound which proved to be too much, the outer whorls of fronds being killed. Likewise an injection of 18 liters of a 0.2 per cent copper sulfate solution into the trunk of a 12-year-old palm was distinctly injurious. The centers of these particular palms, however, are green and it is believed that they will eventually overcome the initial toxic effect. As to the manner in which this chemical produces the surprising, beneficial results one can at this stage only speculate. Copper may be an element essential to the growth and health of the date palm. Being very toxic to some fungi the copper ion may be instrumental in the extermination of some root parasite, although our pathological work so far has not given us such an indication. The copper sulphate may by precipitation inhibit the action of possible soil toxins. Likewise it is possible that the compound could by certain base exchange phenomena liberate from an unavailable state sufficient of the elements, as potassium, phosphorus, etc., for successful date culture.

As already indicated, to supplement our field trials we are studying the physical and chemical properties of a large number of soil samples from both healthy and decline-diseased areas. There were no significant differences in the acidity of the two classes of soils. Thus far our results indicate that in any one garden the soil of the third to the fifth foot inclusive below the surface, which stratum contains the largest number of roots, is in the decline-diseased areas sandier and lighter than in the same zone under healthy trees. Roughly our method was to determine the volume of a given weight of soil, the samples having the greater volume being considered of the heavier type or more clay-like. This determination was checked by measuring the air space in the soil, the air being displaced by a measurable amount of water; the more air space a soil contains, the nearer it approaches the heavier types or clays. This does not mean that date culture cannot be pursued successfully on the light soils, but indicates that, providing date palm decline is a nutritional trouble, it is necessary to fertilize such areas very heavily if the trouble is to be excluded. We are determining also the potash, phosphorus and nitrogen of water extracts of the soil samples. Details of some of our results have recently appeared in the University publication, Hilgardia, under the title 'Some Observations and Experiments on the Nutrition and Composition of the Deglet Noor Date Palm in Relation to the Decline Disease." While Hilgardia is available to any resident of the State and can be secured through the Farm Advisor, Mr. Winslow, a summary of that paper will nevertheless be included in this report.

Summary

(1) A serious malady, "decline disease," has appeared in the date gardens of the Southwest. It is characteried by retardation and eventual cessation of growth, destruction of roots, and gradual reduction in quality and quantity of fruit produced. The Diplodia disease is frequently associated with the decline.

(2) Comparative analyses show that the diseased pinnae are lower in carbohydrates, total nitrogen, potassium, and phosphorus, but higher in calcium than the healthy pinnae. There were no appreciable differences in the sodium, magnesium, total sulfur, and total chlorine of diseased and normal pinnae. Copper sulfate applied to the soil about one badly diseased palm has in three months effected a great improvement as shown by new growth and by the composition of the pinnae. Subsequent fruitfulness also indicated further improvement. No control palms have been known to recover.

(3) There is a great variation in the ash of the dry matter of date pinnae ranging from about 12 to 29 per cent. Date pinnae are highly siliceous, containing from 9 to 25 per cent of silica in the dry matter. About 80 per cent of the ash is silica. Seventy-four to 80 per cent of the total calcium and 87 to 99 per cent of the total potassium of the pinnae are water-soluble.

(4) The pulp of dates dried at 70° C. contained about 1.0 per cent of potassium and about 0.1 per cent of calcium. Over 90 per cent of the inorganic constituents of the dry matter of date pulp is water-soluble.

(5) The potassium content of the dry matter of the roots is three to four times as large as the calcium and is considerably higher than the potassium found in the pinnae or fruit.

(6) Date seedlings (Thoory variety) in culture solutions were apparently uninjured by concentrations of sodium chloride below 4,000 p. p. m. Certain elements such as beryllium may be extremely toxic to Deglet Noor date seedlings.

Effects Due to the Fungus Thielaviopsis

In addition to the fungus diseases reported last year we have found several new diseases due to definite parasites. The most important of these is caused by a fungus, Thielaviopsis sp.* which thus far has been found attacking all organs of the palm except the roots and stem, and our inoculations indicate that it will attack these organs also. Dr. Fawcett has proposed the name "black scorch" for this disease, for it appropriately describes its most striking ultimate symptom, a dull charcoal-like darkening of the affected tissue.

The fungus Thielaviopsis paradoxa parasitizes a number of plants, including areca palms, oil palms, sugar cane, cocoanut and pineapple. On wounded citrus fruits it produces a firm dark, smoky-colored, pleasantly

*Identified as Thielaviopsis paradoxa (De Seyn) v. Hohn by Dr. John A. Stevenson of the Office of Mycology and Disease Survey, U. S. Dept. of Agriculture, Bur. Pl. Ind.

aromatic decay. In India it has been shown experimentally to be capable of attacking plantain, mango, Saccharum spontaneum, Rhapis sp., and the date palm. Excepting our paper in Phytopathology 20:(10), 1930, it is believed that the organism has never been reported attacking the date palm naturally. Last spring the causal fungus was isolated from diseased spathes and inflorescences collected by Mr. Nixon of the Government Date Garden.

On preserved specimens of apparently the same disease sent by Dr. Fawcett from Egypt and Algeria, we have found conidia typically like those of the Thielaviopsis. The parasite attacks the young fruit stalks and fruit strands even before the spathe has ruptured, as shown in one of the slides. On the spathe circular to elongated lesions, sorghum brown (Ridgway) on the exterior surface and ranging from this color to a mahogany red or bay on the interior surface, marked the points of entrance of the disease. On removal of a portion of the infected spathe it was found that the fruit stalk bore depressed, brown (warm blackish) to black necrotic areas which were circular to oblong in outline. The twisted deformed fruit strands of this specimen, which were completely involved by the malady, were a blackish brown to black in color and were devoid of flowers. Microscopic examinations showed them to be covered by dark brown, unicellular, oval conidia. The strands of fruit bunches that were attacked later in their development had blackened, depressed lesions similar to those on the fruit stalk, and some were completely severed by the decay. The affected tissue was in all instances dry and firm, and each area bore the black powdery spores. A gray covering on some of the lesions was found to be due to conidia of Fusarium spp.

While the malady has features in common with the Khamedj disease of date palms in Northern Africa, which has been described by Cavara, Chabrolin and others, the black lesions do not have the white, tomentose covering of the fungus Mauginiella scaettae Cav. to which they ascribe the cause of Khamedj. From the interior tissue of the material collected at Indio a torulae-like Hyphomycete, Thielaviopsis sp., was invariably isolated. On culture media this organism produces a white, aerial growth having chains of hyaline conidia which darken as they mature, the entire culture rapidly becoming dark.

Perhaps even more serious than on the fruit stalks is the effect of the disease on the palm bud and heart. Having gained entrance to the succulent tissue through a wound or puncture, the progress of the pathogen in this vital region is very rapid. The entire terminal bud and adjacent leaf bases may succumb, eventually presenting a dried, dull, blackened, charcoal-like appearance.

In three of the four cases observed the entire bud was not killed, but grew out laterally producing the so-called "fool disease" effect described at last year's Institute. It is believed that the Thielaviopsis is the principal organism responsible in this peculiar trouble. Eventually, the entire bud regenerates from the uninjured meristematic tissue and returns to its normal vertical position. High temperatures and rapid growth of the palm may be the factors operating to prevent the disease from terminating fatally in all instances. On laboratory media the fungus makes very little growth at 32° C. (89.6° F.) or above. Its optimum temperature lies between 24° C. and 27.5° C. (75.2° F. and 81.5° F.). Successful inoculations have been obtained on a large vigorous date seedling in the greenhouse, the disease experimentally produced being similar in appearance to that found in date gardens. The causal organism was easily reisolated from the experimentally diseased material.

The blackening of the midrib of fronds that usually accompanies bud scorch may frequently be due to the same organism. The cross-cuts and V-cuts so commonly found near the base of a midrib present an ideal entrance for this and other fungi. Ashby has reported the fungus attacking the pinnae of the freshly opened leaves of cocoanut palm. Pale yellow spots with a brown margin developed on the furled pinnae, later the lesions elongate, converge, and turn black owing to the presence in the tissues of spores of the fungus. Infection spreads rapidly through the pinnae and in severe cases the heart leaves dry up. This is an accurate description of the course of the disease we produced on the large seedling in the greenhouse.

Several midrib bases of the second whorl of fronds on a large seedling offshoot were inoculated by placing the fungus in a ⅛-inch hole made with a cork borer. The wound was covered with adhesive tape until the organism was established. In four weeks the fungus on one frond had produced an oval lesion 3½ inches wide and 6 inches long, almost enveloping the midrib and causing it to break. Extending a total of 18 inches up and down the surface of the midrib beyond the lesion was a linear series of circular water-soaked areas each about ½-inch in diameter. The surface of the canker was gray to brown to drab in color, and the pinnae beyond turned gray as they dried. Internally the lesion was a light drab to a wine color toward the advancing edges with smaller orange to reddish brown streaks extending far up and down the midrib. These streaks were directly under the water-soaked areas that appeared on the surface. The pathogen was readily reisolated from the affected tissue. Eventually the invaded tissue turns black due to the production of the black spores of the causal fungus.

This disease may become of serious economic importance if rainy or humid periods occur during the time the spathes are opening. However, some preliminary experiments in the laboratory indicate that copper sprays or dusts may control the trouble. According to reports the disease on areca palms in India was successfully treated by excision of the infected parts, scorching the wound and applying hot tar. Some success was had with sugar cane sets by dipping them in 4-5-40 Burgundy or Bordeaux mixtures. In Jamaica where the malady occurs on cocoanuts, the diseased tissues are excised and the wounds dressed with a mixture of equal parts of copper sulfate, salt, and lime. On the date palm it is highly probable that surgery followed by a disinfection with some copper spray or dust would be effective.

The Diplodia Disease

Work on the Diplodia disease has been continued. A survey revealed that a number of varieties of the date palm are susceptible, the typical darkened, elongated lesions being found on the frond midribs of 20 different varieties. The organism together with a Fusarium has recently been found on several decaying male inflorescences collected by Dr. Swingle.

In cooperation with Mr. William Cook, Cook Date Gardens. Indio, some experiments were made to determine the efficacy of dipping Diplodia-diseased offshoots in various disinfectants prior to planting in the nursery or field. One per cent solutions of Arrow carbolineum, po-

tassium permanganate, copper sulfate, 2 per cent solutions of formalin and licresolis, a 10-10-50 wet Bordeaux mixture, ammoniacal copper carbonate, and a Bordeaux dust were the disinfectants tried in a preliminary experiment. All the offshoots used showed evidence of Diplodia infection. They were immersed in the solutions up to but not including the bud. In the case of the Bordeaux dust, a very thorough coating of the material was given. None of these treatments seemed to injure the offshoots and all eventually became established in the nursery row. Those dipped in the copper materials (ammoniacal copper carbonate and Bordeaux) were the first to put out new leaves, suggesting a stimulating effect.

Five hundred offshoots were later dipped in ammoniacal copper carbonate solution (5 oz. $CuCO_3$ dissolved in 3 pints of ammonia in one gallon of water and then diluted to 50 gallons) and planted in the field. Only 15 per cent of these offshoots failed to establish themselves, which, considering that they were diseased, was a good average last season when many growers were losing 25 per cent or more plantings. Quoting Mr. Cook: "There is very little more to add in connection with the dipping experiment last year. I am very much pleased with the results and will dip all shoots cut this year.

"The eleven first dipped all have done well, and are as healthy as one could expect a choice shoot to be, which they certainly were not when they were selected. At the present time I can see no difference in them that can be attributed to the different treatments. All are growing as well, or better, than could be expected and no one type of fungicide would appear to be especially better. I hope to be able to make a slightly more informative test with copper sulfate this spring, and see if it will stimulate the newly planted shoots." It is of interest at this point to recall the beneficial effect of soil applications of copper sulfate."

While searching for Diplodia-affected fronds one frequently encounters a species of bracket fungus, Poria sp., growing on the frond fiber that surrounds the trunk of the palm. It is believed that this fungus grows only saprophytically on the fiber and need occasion no alarm.

Dry Bone Disease

Dry bone, while in general of minor importance in the commercial gardens, has been found doing considerable damage on some seedling palms. In the early stages this trouble appears often as extremely elongated, grayish white, slightly elevated areas with a reddish brown margin. These areas sometimes almost completely envelop the midrib of the frond and extend out upon the pinnae. Where the outer white layer is carefully removed, one finds that the reddish brown margin actually marks the boundary of a lower dark layer of the same color. Numerous isolations have yielded principally a certain type of bacterium. Inoculations with this bacterium are yielding results which indicate that it may be the pathogen.

The typical symptoms of blotch are frequently found to be associated with rubbings and other injuries; in other cases, especially on the ends of younger fronds, it is impossible to connect the blotches with any mechanical injury.

Graphiola Smut

The Graphiola smut of fronds has been observed on date palms at El Centro and at the Bard Station in Imperial county, California, and at Yuma and Tempe, Arizona. It appeared in every case to be of minor importance.

Fruit Troubles

Observations on date fruit troubles have been continued. In addition to those reported last year more observations have been made on blacknose. Treatments of bunches of dates in the field respectively with a hydrocarbon sulphur dust, a Bordeaux dust, and sprays of 1 to 40 lime sulphur, ammoniacal copper carbonate, and 5-5-50 Bordeaux mixture gave some interesting indications, although the work was not sufficiently extensive to justify the recommendations of any commercial practice. The materials were applied three times at month intervals beginning June 4, 1930.

The bunch sprayed with the 1-40 lime sulphur had no blacknose dates, but was less mature than the untreated check bunches. Those sprayed with Bordeaux mixture and ammoniacal copper carbonate were more mature than the checks and had approximately the same amount of blacknose. The hydrocarbon sulphur dust had no apparent effect on maturity and incidence of blacknose. The bunch dusted with Bordeaux had slightly less blacknose than the checks and about the same degree of maturity.

Possibly of no commercial interest, but interesting scientifically were some bunches completely enclosed by paper bags and exposed respectively to the vapors of carbon disulphide and carbon tetrachloride by tying open bottles of the chemicals in the tops of the bunches. The carbon disulphide-treated bunch had 30 per cent blacknose and abundant decay due to Aspergillus niger, A. flavus, and Penicillium, as contrasted to a bagged check bunch which had less than 1 per cent blacknose and very little rotting and spotting. The bunch treated with carbon tetrachloride showed intermediate effects, having 10 per cent blacknose and slightly more of the Aspergillus and Penicillium decay than the checks.

The vapor-treated bunches also matured more rapidly than the untreated. Strands of dates enclosed in bottles over water matured much less rapidly than the other strands of the same bunch. Seemingly materials and conditions that hasten transpiration and evaporation hasten ripening. It has been shown that plants sprayed with Bordeaux transpire more rapidly than unsprayed plants. Also, it is likely that the vapors of carbon disulphide and tetrachloride increase permeability and accelerate transpiration.

Furthermore, the above experiment lends support to the theory that the injury which ultimately results in blacknose takes place under certain drying atmospheric conditions when the date transpires water faster than the sugar manufactured in the leaves can be translocated to the fruit. In addition we have collected and prepared for chemical analysis a large number of fruit samples.

Comparative chemical analyses of the basal and distal ends of blacknose dates and of whole dates of susceptible and insusceptible varieties may yield some clues as to the chemical composition responsible for, accompanying, and resulting from this important trouble.

What may be a serious fungus pest on cured and packed dates has come to our attention. This organism, Catenularia fuliginea,* grows very rapidly on ripe dates, sporulating in reddish brown, monilia-like cushions and rendering the fruit unfit for sale. A steam bath of 95° C. to 100° C. for one minute was found sufficient to kill the organism.

Strands of dates in the khalal and early rutab stages, some unwounded and some wounded by pricks of a needle, and half of the wounded and

*Identified by Dr. Charles Thom, Bureau of Chemistry and Soils, U. S. Dept. Agriculture, Bur. Pl. Ind.

unwounded being thoroughly dusted with dry Bordeaux, were placed in deep culture dishes (used as moist chambers) and inoculated respectively by spraying on spore suspensions of nine species of fungi found associated with date maladies.

Previously a study of the inhibitory effect of several fungicides on spore germination of several date fungi had shown the copper sprays and dust more effective than the dusts and sprays of sulfur or lime sulfur. The organisms included Alternaria, Helminthosporium, Diplodia, Phomopsis, Thielaviopsis, Aspergillus niger, a green Penicillium P. roseum, and Catenularia. It will be recalled that in the field, Alternaria, Helminthosporium, Aspergillus and Penicillium are the most prevalent decayers of date fruit.

All cultures were incubated at room temperature (22°-25° C.). This experiment was a continuation of that recorded in the paper presented last year. Judging by the numbers of decayed spots that formed. the Bordeaux-dusted fruit was less affected than the untreated fruit, suggesting that field treatment with that fungicide might be feasible and desirable during rainy seasons.

Under the conditions of the experiment the rate of decay by the fungi from highest to lowest stood: Catenularia, Aspergillus, P. roseum, Penicillium sp., Phomopsis, Helminthosporium, Alternaria, Diplodia, and Thielaviopsis.

The temperature of incubation was considerably lower than the optimum for several of the fungi. Eventually, however, all but the individual very immature dates became involved by all the fungi. Again it was indicated that all the fungi, with the possible exception of Alternaria and Helminthosporium, are wound parasites. The Catenularia, however, apparently grows abundantly on the cuticle of the date if sufficient moisture is present. On stored dates it often completely enveloped the dates growing in the syrup that forms on the surface of the wet-processed dates.

The effect of water and high humidities on Deglet Noor dates is shown in one of the lantern slides. Dates in the khalal and early rutab stages immersed two to five hours in water developed many large cracks. Dates placed in a saturated atmosphere would take up water and develop very severe ruptures usually near the tip end.

Strands of dates were placed respectively in atmospheres with relative humidities of 0%, 10.5%, 21.5%, 38%, 49%, 60.7%, 70.4%, 80.5%, 89.9%, and 100% to test the effect of atmospheric moisture on the production of cracks. These humidities were obtained by use of sulfuric acid of various concentrations. (See Stevens, N. E., Phytopathology 6:428-432, 1916). Only in chambers having 100%, 89.9%, and 80.5% humidities (only few cracks in the second and third) did the cracks develop and the dates rapidly were covered by several species of Penicillium and Aspergillus. The fungi became less in evidence as the lower humidities were approached, there being none in the chambers at 0%, 10.5%, and 21.5% humidity. At these three lower humidities there occurred a slight, but distinct shrinking of the fruit.

I shall conclude by pointing out that in the field it has been observed that fruit from low hanging bunches, especially on young palms, is frequently of poor quality and breaks down more readily than the high hanging fruit on older palms. If the younger palms are irrigated when the fruit is in the late khalal and early rutab stages, a great deal of rot may develop. Some of this decay is undoubtedly due to the cracks that develop in low hanging fruit due to condensation water and high humidities.

From the above the relationship of rains and excessive humidity to spoilage is at once apparent. The exposed inner tissues, rich in food, probably present a very good medium to practically any wind-borne fungus spores that chance to lodge there, as was evinced by the abundant and diverse flora that developed on the experimental dates.

DISCUSSION

R. H. Postlethwaite: A very valuable paper from a purely scientific standpoint but to the uninitiated it might appear that the date palm suffered from every known disease from double pneumonia to housemaid's knee, whereas actually the industry has only suffered from two diseases which have commercial importance, Parlatoria Scale which, under the able management of Mr. B. L. Boyden, representing the Federal Horticultural Board, is almost eradicated, and a so-called Decline of Palms, the cause of which is still obscure but for which a remedy appears to have been found by the Citrus Experiment Station, Riverside.

Observations on the Culture and Diseases of Date Palms in North Africa

By H. S. Fawcett, Professor of Plant Pathology, Citrus Experiment Station, University of California

I WAS privileged to travel in Tunisia and Algeria during the greater part of January and February and in Egypt in March, 1930, to study the date palm conditions, but especially the date palm diseases. This was made possible in part by a joint arrangement between the Bureau of Plant Industry of the United States Department of Agriculture and the Citrus Experiment Station of the University of California. It was considered to be desirable to make a careful observation of the diseases of these countries in relation to those we already know to be present in California and the southwest.

Since many thousands of offshoots have been imported from certain regions of North Africa before any serious study of date diseases was made, we have probably imported already most of the diseases of these regions that are capable of being carried on young palms to this country. If the diseases had been thoroughly studied before this time, most of them might have been prevented from entering this country. No blame is to be attached to those importing the palms, however, since nothing was known of the diseases at the beginning of importation.

The situation, however, furnishes for the future a good argument for a thorough study of diseases of any given crop in the country where it is grown as a basis for intelligent handling of its importation into new locations. This now applies especially to the Bayoud disease in Morocco. Fortunately, we have so far been spared this most destructive date palm disease yet known. Our escape from the Bayoud disease is probably due to the fact that no successful importations are known to have been made to California or Arizona from the oases now known to contain this disease. The only palms in this country from the general region, suffering from this disease, were those of the Medjhool variety sent from a disease-free garden in Morocco by Dr. W. T. Swingle to an isolated place in the desert in Nevada, as explained in detail by Dr. W. T. Swingle on page 18 of your annual report for 1929. These palms are still quite free from disease after a period of about four years, but are still being carefully watched under strict quarantine.

The region having the Bayoud disease in North Africa is confined to parts of Morocca below the high Atlas Mountains, and to a few oases just over the border in western Algeria. All the remainder of Algeria, all of Tunisia, Egypt and Mesopotamia, so far as known, are free from the disease. Further details of this disease will be found later in this paper.

According to Popenoe there are at least 90,000,000 producing date palms in Northern Africa. These are scattered in various oases, especially in the warm, dry regions of Morocco, Algeria and Tunis, and in various parts of Egypt from the Mediterranean coast to the Sudan.

During this date disease investigation I have received the greatest courtesy and help from many persons in these countries. I wish to mention especially Dr. Rene Maire and Dr. Charles Killian of the University of Algiers, Dr. Charles Chabrolin of the Agricultural School at Tunis, and Dr. Monir Bahgat of the Mycological Division of the Ministry of Agriculture, Cairo, Egypt.

EGYPT

In Egypt, as has been pointed out by Professor Mason,* there are two large districts where seedling dates are almost exclusively grown, and three other widely separated districts where offshoots of commercial varieties are used. The northernmost area extends to the Mediterranean and the southernmost to Atbara in the Sudan, a north and south extension of about 1,000 miles. Lower Egypt from the Mediterranean to about 15 miles above Cairo is the most important of the varietal date regions. Above this, along the Nile to Aswan and including the Fayum district, is a region with seedling dates. It was parts of these two regions that I visited while in Egypt. The principal varieties in lower Egypt are: Hayany, Samani, Zagloul, Amhat and Saidy.

One is especially impressed in Egypt with the wide use made of all parts of the date palm. Roofs of houses, arbors, and fences are made from the whole leaves; crates and boxes are made of date palm midribs; mats, rope, hats, baskets and handbags from the leaf pinnae; posts for houses from the trunks, and any left-over bits for fuel; in fact every part is carefully utilized for some purpose. Professor Mason has described these uses in detail. One finds the palms commonly trimmed very high and near to the fruit stalks, sometimes leaving only five or six leaves near the top at the time of trimming. Some pruning of leaves was being finished during the middle of March while I was there. A part of the pollination in the delta region near Cairo appeared to have been done by that time. At Fayum, forty miles southwest of Cairo, on March 18 some spathes were fully open and pollinated, others just splitting and some not yet open.

The price received for dates in Egypt seemed very low. The growers were receiving not more than 1 to 1½ cents per pound. At Damietta good trees were said to average about 250 pounds per tree of the Hayany variety (known locally as Ramli) for which was received about one dollar to $1.50 per tree, not far from ½c per pound.

The principal disease of date palms found in Egypt was the Graphiola or leaf smut, due to the fungus Graphiola phoenicis, which occurs as numerous pustules on the pinnae of the leaves. These pustules are dark brown or black. They are about ½ to 1 millimeter in diameter and extend out from the surface of the leaf. The leaf tissue immediately surrounding the pustule is often yellowish in color. The disease appeared to be most conspicuous on the older lower leaves. It was conspicuous and widely distributed in the delta region and at Fayum, but was absent in the dryer oases with less humidity. The close trimming of the leaves was said to keep it down to a point where little injury to the trees would result. Near the Mediterranean Sea, however, along the Nile, I observed that the palms were so badly infected with this fungus that I believe it must interfere considerably with the growth and production of the palms. No treatment was being used against this disease. I could get no definite information as to whether or not the pruning off of so many of the leaves would lessen the production of dates.

At Fayum I found specimens of the black scorch on leafstalks similar to the disease which I had previously noted in Coachella Valley on emerging buds and the cause of which Dr. L. J. Klotz has found to be the fungus Thielaviopsis paradoxa. The disease at Fayum, Egypt, was found in the form of a blackened, rough, irregular scorched condition along the side of a young leafstalk. The various phases of black scorch are being described by Dr. Klotz in another paper in this report. Specimens also containing spores similar to this Thielaviopsis were found in Tunisia and Algeria.

I found no other disease of date palms in Egypt that appeared to be more than of minor importance. At Alexandria, Korashia and Fayum I found the Diplodia disease only in a very mild form. At Fayum I found on leafstalks brown oval spots about 10 to 15 mm. in longest diameter with pink tissue underneath extending inward for about 5 to 10 mm. No organism was found either by microscopic or cultural methods. Near Alexandria and Mamietta similar oval spots were found on leafstalks. In addition, dark brown, more irregular oval spots on the midrib portion of the leaves were commonly seen, resembling what will be described later under Tunisia as anthracnose. A superficial spot to be known as dry bone, also to be described later, was noted. Small reddish brown spots 3 to 4 mm. in diameter on leafstalks were probably stigmanose. They were thought by one of the Egyptian entomologists to be possibly due to some sucking insect like the jassid. No sign of fungi could be found in the discolored tissue. On various minor spots on date palm midribs in Egypt various fungi were found, including species of Anthostomella, Phomopsis, Phoma, Gloeosporium, Didymospor-

*Mason, S. C. Date culture in Egypt and the Sudan. U. S. Department of Agriculture Bull. 1457, pp. 1-71, 1927.

um, and Mycosphaerella in addition to those previously mentioned.

TUNISIA

In Tunisia the principal date growing districts were to the south and inland in dry, hot oases with climates not unlike the Coachella Valley.

Kearney* has published a fine account of date growing in this region. I visited the oasis of Tozeur and several other smaller oases nearby. At Tozeur about half of all the dates (400,000 trees) now grown is estimated to be Deglet Noor. Four other varieties of most importance there according to a leading Arab grower were: Bou fagousse, Ftimi, Kenteechy, and Kanta.

Most of the palm area there is planted irregularly at various distances apart and not in regular rows. Only in recent years have certain Frenchmen begun planting in regular rows and developing a system of irrigation and culture along much the same lines as that in California.

In one of these best developments by a French association of growers in the vicinity of Tozeur, 15,000 Deglet Noor palms had been planted in rows 25 feet apart. The offshoots had been brought from at least 15 different oases, those from each oasis planted in a separate block. The owner had expected to find different strains of the Deglet Noor, some of them superior to others, but when they came into bearing he could detect no differences even between those originating in widely separated oases.

Irrigation there was from deep wells and the water was run in squares about the trees. Deep, open drainage ditches between the rows were also employed to prevent salt accumulation. There were canals along the margins of the blocks of trees, fine buildings with a well furnished office and a club house and library for the employes. Parlatoria and Marlatt scale insects were present on a few trees in one corner of the development. Two kinds of maggots were said to be troublesome in the fruit, one pink in color, the other white.

At another development, somewhat older and not far from a salt marsh, a system of drainage ditches four to six feet deep leading into the marsh, some of them open, others with tile, were being used with much benefit to the trees. Some of these drains were laid by tunneling immediately under the younger palms. These drains tended to keep the concentration of salt from getting too high in the soil. The contrast between those with drainage and those without drains was very great in rate of growth and production of fruit.

For fertilizing, animal manure, especially that of the camel, was thought to be the best, but sulphate of ammonia and calcium nitrate were also employed.

Deep wells are put down to get water for irrigation, some as deep as 90 feet, having been dug by hand before the modern use of machinery and metal pipes. The old method of digging deep wells was to line the sides with Palm trunks as the well was being dug down through the sand. When the water began to come in, digging was continued at the bottom of the water, employing Arabs who were good divers. Each Arab could stay under water for about three minutes while digging as much as possible in that time, then come up to the surface and another would take his turn, etc. By having a large number of such divers going in one after the other, taking their turns, the well was slowly deepened.

A matter of local importance is the juice of the palm used as a drink both fresh and fermented. A palm will yield several liters per day over a period of some weeks. Palms that do not bear well and become unproductive are used for obtaining juice. The leaves near the top are cut close up to the bud; the bud is cut into, but not enough to kill it, so that it will give forth juice through channels in the tissue into vessels hung below the bud. For a year or two after this treatment of the bud, no fruit is produced, but the tree recovers, leaving a pronounced and permanent ring around the trunk at the wounded portion.

Diseases in Tunisia. The most important disease of date palm in Tunisia appeared to be a disease of the inflorescence, known as Khamedj, due to a fungus Mauginiella scaettae Cav. This has recently been investigated and described in detail by Dr. Charles Chabrolin** of Tunis. (The very destructive Bayoud disease of Morocco, to be described later, had not yet appeared in Tunisia.) The Khamedj is distributed in Tunisia, Algeria, Morocco and Italy, and Dr. Chabrolin believes it exists also in other countries of the Old World. Its absence in California and Arizona may be due to the fact that it attacks only the inflorescence and would therefore not be so likely to be brought in on offshoots to this country.

In the Khamedj disease the inflorescence is attacked before it comes out of the spathe. As described by Chabrolin, the first visible symptom is a spot showing on the surface of the spathe. This enlarges as the fungus spreads over a greater part of the inflorescence inside. In severe attacks the spathe does not open and the contents finally dry out. If the inflorescense gets free from the opened spathe, the brown tissues dry out. The brown tissues are covered by abundant white powder produced by the spores of the attacking fungus. Infection is thought to take place through the spathe from the exterior without injury. Dr. Klotz has found a similar effect of the black scorch fungus, Thielaviopsis paradoxa, but the spores are black instead of white.

Dr. Chabrolin has obtained in his experiments good control by means of powdered Bordeaux dust which was sifted in by hand between the sheath of the leaves in the region where future spathes would push up. Two applications are recommended—one after the dates are harvested, the other before flowering.

The Diplodia disease which I had previously investigated in California was found in a mild form near Tozeur, Tunisia. It was first definitely noted on some male palm leafstalks and later on leafstalks of Deglet Noor palms. On inquiry it was learned that offshoots from these same oases had been sent to the United States. I have already described this disease in Phytopathology.* The symptoms are briefly as follows: In severe cases the disease results in death of offshoots either while they are still attached to the mother palm or after they have been detached and planted out. The disease sometimes also causes a premature death of leaves in older palms.

In offshoots the disease manifests itself in two distinct types: one, in which the outside leaves die first and the younger shoots and bud remain

*Kearney, Thos. H. Date varieties and date culture in Tunis. U. S. Department of Agriculture Bureau of Plant Industry Bulletin 92, 1906.

**Chabrolin, Charles. La pourriture de L'inflorescence du Palmier-Dattier. Annales des Epiphyties 14:377-414, 1928.

*Fawcett, H. S. An offshoot and leafstalk disease of date palms due to Diplodia. Phytopathology 20:339-344, 1930.

alive for some time; the other, in which the dying-back of the center of offshoot or bud precedes the death of the older leaves.

In the leaves of older palms the ventral midportion of the stalks is the part most commonly affected, showing yellowish brown streaks running upward 6 inches to 3 or 4 feet from the base. The disease may spread laterally from one leaf base to others in close proximity. Frequently, these streaks extend upward on one of the lateral angles of the leafstalk.

The Graphiola or leaf smut referred to under "Egypt" was also common in northern Tunisia, but appeared to be absent in the dry, hot oases of southern Tunisia. It was, therefore, not of commercial importance. This same relation to atmospheric moisture, limits this disease also in other countries. In Egypt and Algeria it does not occur in the dryer oases. In California it is most in evidence near the coast, as at San Diego. It occurs not so abundantly at Yuma and the Salt River Valley, Arizona, and is absent in Coachella Valley.

Other diseases of minor importance seen in Tunisia were the Mejnoun or "fool" disease, anthracnose, and dry bone.

The Mejnoun or fool disease causes the bud of the palms to grow sidewise instead of straight upward. Only a small percentage, possibly 1 per cent, act in this way. No definite reason for this was known. The method of curing such trees was to cut off all leaves close to the trunk up to the bud, pulling away all the fiber. Usually after such treatment the bud will grow up straight and become normal. As Dr. L. J. Klotz has brought out, we think that this turning sidewise in California may be associated with an attack of the Thielaviopsis fungus, but whether this is the cause in North Africa is uncertain.

A minor disease known as anthracnose by one of the Frenchmen at Tozeur was characterized by deep reddish brown, chocolate or black spots on the leafstalks and midportion of the leaves. The spots were ¼ to 2 inches in greatest diameter, with indefinite, irregular margins. These spots affected only a thin layer of tissue. These appeared to be the same type of spot as was seen in Algeria, Egypt and one garden near Nice in southern France, and a similar spot occurs in California and Arizona. A fungus apparently related to Gloeosporium was found in the spot in North Africa.

A minor disease which is known as dry bone was also seen in Tunisia. It was seen also in Egypt and Algeria and is known in California. This is characterized by whitish, irregular blotches and streaks on the leafstalks, midribs and pinnae. It also affects the epidermis and only a thin layer of tissue. The spots, blotches and streaks are very variable in size, from ¼ inch to several inches in largest diameter. With age they become definitely outlined and the surface drys and presents a hard, smooth, white appearance suggestive of the name dry bone given to it by Professor Mason. Certain palms appear to be much more susceptible than others. It is thought to be due to a bacterium which is commonly found associated with the lesions in their early stages.

A fungus commonly found on stalks of old palm leaves was Anthostomella sp. Dr. Rene Maire identified specimens from Tozeur and El Golea as Anthostomella affinis molleriana. What appears to be the same or a similar species I have found since in Palestine, Arizona and California.

ALGERIA

In Algeria two trips were taken into the oases where date palm culture was important; one about 1,000 kilometers south of the city of Algiers through the oases of Bou Saada, Laghouat, Guardia to El Golea; and the other south of Oran nearly the same distance to the Beni Ounif and Figuig sections on the western border of Algeria and the eastern border of Morocco below the Atlas Mountains.

Algiers to El Golea. On this first trip in Algeria, I was privileged to be invited as a foreign representative to travel with a party of French delegates to the Congress of Roses and Oranges held at El Golea the latter part of February, 1930. We were about 50 in all, traveling in large, double-tired desert auto buses and stopping at each of the important oases along the way. This gave an opportunity to observe the date palm culture and conditions at these various places.

Traveling inland and southeastward from Algiers, the capital of Algeria, we went first through a flat, rolling country growing wheat as the principal crop, but with small orchards of citrus, mostly of mandarine oranges. Then we traveled through the mountains and plateaus and came to the oasis of Bou Saada. Here we found gardens of oranges, mandarines and lemons in addition to many date palms. The date palm fruits at this first oasis were of poor quality for human consumption (except one variety with small fruit), but were quite an important product as a food for the camel and other animals. This lack of quality was said to be due to the altitude of this oasis being too high, with insufficient heat for the proper maturity of most date fruits. The only disease seen here was the anthracnose, previously mentioned, producing a dark, irregular spot on midribs, like that seen in Tunisia and Egypt. On dead specimens of leaf bases spores resembling Thielaviopsis were found. The oases of Laghouat and Guardia were next visited in turn and here I found only the anthracnose and the Parlatoria scale on palms in each place.

By the fourth day, on leaving Guardia we began to get into the real desert, with wind and dust and rough going. As we stopped to eat lunch, a caravan with large, white graceful camels came up from the south and stopped to rest also. Before leaving we were given an exhibition of the great speed of these racing camels whose owners are among the richest of the Arabs because of the money earned in carrying produce and materials great distances in a short time across the desert. And at another lunch time we had inspected a set of nomadic Arab tents by the roadside. Then, while our backs were turned looking for specimens, they had gone in a remarkably short time. The force of Longfellow's lines was realized: "Fold their tents like the Arabs and silently steal away."

Approaching El Golea, the farthest stop south, in the evening our car was just behind the car carrying the governor of the province. We found the road lined with bon fires, showing beside them groups of the blackest of negroes in native costume, with guns in hand, making a rather frightful spectacles. Suddenly there was a deafening roar as the guns were fired repeatedly in honor of the governor as the cars passed each group along the endless line of natives.

At El Golea date palms were important. Some Deglet Noors were then being grown there, but the principal varieties for this region were said to be Ghars and Cheikh. Others not exported but used locally were Tinnosser, Timjouert, Tigaouin, Takarlouck, and Time-

douel. Here in one part of the oasis we found date palms apparently being stunted by too much salt, but such places were only where the salt was so concentrated that practically all other vegetation was killed. Palms were very vigorous in most parts of El Golea. At El Golea I found only minor diseases; a slight indication of Diplodia disease in a very mild form, the white, irregular spots of dry bone, and the Anthostomella fungus on brown streaks of the leafstalks. I also found one healthy palm with part of its leaves showing one side of midrib and pinnae white and the other a normal green color like the usual chimera effect. Parlatoria and Marlatt scale insects were also common there.

The Bayoud Disease. The second trip in Algeria was to the Beni Ounif and Figuig sections at the boundary line between Algeria and Morocco to see the Bayoud disease.

I left Algiers by train in company with two French pathologists, Dr. Charles Killian of the University of Algiers, Dr. Charles Chabrolin of the Agricultural School in Tunis, and an interpreter. After an all-night ride we were in the desert beyond the mountains. Within 40 or 50 miles of Figuig the train followed rocky valleys or depressions with dry stream beds, much as in the Mojave Desert. Date palms appeared to be commonly spontaneous along these dry beds in smaller or larger clumps, giving the impression that the date palm might be indigenous to this section much as is the Washingtonia in the rocky stream beds off from the Coachella Valley. Bare, purple mountains in the distance remind one distinctly of California and Arizona aspects. The Beni Ounif and Figuig sections are something like the Coachella Valley with its bare, rocky cliffs and low mountains in the distance. The soil is commonly less sandy. The elevation is 2,500 to 2,800 feet above sea level. In the seven distinct oases short distances apart there are, it is estimated, 200,000 palm trees, the fruit of which is an important part of the food for 15,000 inhabitants, mostly Arabs. The water for irrigation comes from springs in this region.

Here is where we concentrated on the investigation of the terrible Bayoud disease, the worst disease, I believe, I have even seen on any plant. It would be difficult to exaggerate its seriousness. It is destructive in at least four of the seven oases of this section as well as in a number of other sections farther west in Morocco south of the Atlas Mountains. One of the first symptoms of the disease is a whitening of the leaf, usually a younger leaf near the center of the palm. When this shows, it is a sign that the palm will usually be dead in six to twelve months. Palms 50 to 100 years old bearing large quantities of fruit die one after another and large areas are killed out completely. The later symptoms are faintly off-colored streaks on the leafstalk and midrib portions. In severe cases these streaks resemble somewhat the streaks due to Diplodia, but it is very different. The diseased leafstalks when cut into show light to dark brown discoloration of the interior tissues. One often finds a pink discoloration in the fibrous interior of the trunk. We found it difficult to trace the discoloration accurately and to arrive at a definite idea of where the disease first entered the palm. The roots in the beginning stages generally seem sound. The progress of the disease is quite often one-sided and gives the general impression of starting at or above the base on one side. We three pathologists spent considerable time cutting up and carefully examining palms in several different stages of the disease. We also made a series of isolation tests on culture media from various parts of diseased tissue. These were all left at the University of Algiers with Dr. Killian. He reported to me later by letter that he had found a certain fungus fairly generally distributed in these cultures, but it remains to be determined whether the fungus is the primary cause of the disease. Maire and Killian* have since described the fungus under the name of Cylindrophoro albedinis.

This disease is thought to have originated many years ago in parts of Morocco far below the Atlas Mountains where the native tribes are now in rebellion against the French, and in more recent years has spread to new oases. The Arabs say that these original areas have some date palms which are apparently resistant to the disease and this fact holds out the only hope for the replanting of the gardens now being killed out.

The investigation of this disease, to determine its cause and how to deal with it, appears to me to be of international interest and of the gravest importance. If it should spread into the other date regions of the world, including our Southwest, with our present lack of knowledge regarding it, the results might be very serious before we would have time to find methods of dealing with it. In my opinion it will be great economy and insurance to thoroughly investigate it before it gets here rather than afterwards. I have been using every effort to stimulate interest in some kind of cooperation between certain institutions and the French authorities to get more investigation started on this disease for our own protection and the protection of date culture the world over in the future.

All other diseases of minor importance were as nothing at Figuig in comparison to the Bayoud and I almost forgot to look for them. I did find, however, a trace of Diplodia disease on leaf bases, some anthracnose spots on midribs, and some of the Anthostomella fungus on older leaf bases.

SUMMARY OF DISEASES

The Bayoud disease of unknown cause with which Maire and Killian have usually found associated a fungus, Cylindrophoro albedinis, is by far the most destructive of all date palm diseases. It occurs in Morocco south of the Atlas Mountains and has now spread over the border into western Algeria in the Beni Ounif section. Its seriousness calls for immediate investigation in which international interest should be stimulated.

The Khamedj disease of the inflorescence due to the fungus Mauginiella scaettae is known in Tunis, Algeria, Morocco, and in Italy as far north as San Remo, but has not been observed in Egypt, Arizona or California.

The Graphiola or smut disease of date palm leaves due to a smut-like fungus, Graphiola phoenicis, is widely distributed near the coast of the Mediterranean and inland where the humidity is sufficient. It is also present in most places in Southern California, except the Coachella Valley, and in a mild form in Arizona. Its absence in the dryer interior oases in Africa and its absence in the Coachella Valley is probably due to unsuitable humidity relations for its infection and development.

The Diplodia disease which was first found in the Coachella Valley in 1927 was found in oases in southern Tunisia in 1930 on Deglet Noor and other varieties, the same oases

*Maire, Rene, and Charles Killian. Le Bayoud, Maladie du Dattier. Gouv. Gen. de l'Algerie Service Botanique Bul. 73, pp. 89-101, 1930.

from which offshoots had been brought to California. What appeared to be a mild form of the Diplodia disease was also seen at Bou Saada, El Golea and Figuig in Algeria, and at Fayum and Korashia in Egypt.

Dry bone, the irregular white spotting of midrib and pinnae which we now think may be due to a bacterium was found in nearly all the date sections of North Africa. It is common in California and Arizona.

Specimens of black scorch associated with Thielaviopsis were found at Fayum and Alexandria in Egypt. Specimens with Thielaviopsis - like spores which suggest the possibility of its presence were found in Tozeur in Tunisia and Bou Saada in Algeria.

The Anthracnose disease probably due to a fungus related to Gloeosporium is usually a minor spotting of the leaf, midrib and pinnae. It was found widely distributed and was noted in Algeria, Tunisia, and Egypt, and has been seen in Arizona and California.

A browning of old leafstalks in streaks with which a fungus, Anthostomella sp., is associated (Anthostomella affinis molleriana) in Algeria according to Dr. Maire, was found in Egypt, Algeria, Tunis, and Palestine, and is also present in Arizona and California.

I was not in North Africa at a season to see any diseases of the fruit.

Different Phases of Date Marketing

The Saturday morning session of the Date Institute was devoted to a discussion of marketing problems and the three papers on this subject that are here published furnished the foundation and basis of the general discussion on grades and methods of selling that took up this session of the Institute.

This discussion was a general asking and answering of questions in which the chairman of the meeting, Mr. Geo. D. Olds, Jr., practically all growers present, and many others that were not actual growers but interested in this subject, all had their part in making the meeting a success.

Perhaps the marketing problem in date growing may be broadly summarized as follows:

1. The ultimate end of selling dates is to make money for the grower.
2. Dates are not sold till they are eaten.
3. Sales begin in the garden, for no packing house can make good fruit out of junk.
4. The first two grades have to carry the load of the rest.
5. The packing house should be guided by the salesman's knowledge of customer requirements for it is the buyer's ideas of grades that will finally be adopted.
6. Selling all dates under one control is the ideal method but can only be achieved when some one individual, or preferably organization, can show the ability and has the capital necessary to make good and give the grower a fair return for his fruit.

Marketing in the Date Industry

By Burdette K. Marvin, Riverside, California

THE request to read a paper here this morning took me unaware as I was starting for Los Angeles last Tuesday. I did not know who would be the other speakers or what they would say. I should prefer to give you that to which you are entitled, viz., a carefully considered summary of my experiences and conclusions. Instead, I can only give you opinions in the raw, requiring some mastication, as it were, for their digesting. In a word, it will be for you to boil down my remarks to their essential meanings, and to skim off their apparent uncertainties.

How shall we consider marketing, from what viewpoint? The foreman, superintendent, manager or owner of a plant may often be seen strolling idly about, perhaps with his hands in his pockets, a picture of leisure to his hard working employes. But, if the said overseer is worth his place, his eyes and his mind are busy noting the way the work is being done. Give any group of workers a piece of work with which they are not familiar and it is ten to one they will do it in a needlessly slow, awkward, laborious way for all their fast movements. Dynamic thinking is more natural to us than is reflective thinking. One day I walked back to the sealing bench and saw an industrious fellow sealing shipping cases of fancy cartons. Each case he sealed and set on the floor behind him, the next on that, the next on the floor alongside. When I got there I had to laugh; for he had surrounded himself with stacks of cases and could hardly jump out. In loading trays, cars, etc., workers think nothing of taking a few steps; and to make time, they step quickly. But an overseer who has in mind the result of the day's labor usually can move the car or only turn it around, yet eliminate the walking. He has greatly speeded loading without speeding the worker; rather, the reverse. He has done this because of his viewpoint to look at the far result, not the immediate. And this viewpoint must be ours, if we are to consider date marketing as a big business. The individual grower may reach for the nearest, easiest dollar; but the sales organization must consider the result of these many individual acts. If the workers in the packing house will not heed the foreman, one means of cutting unit labor cost is lost; and, so, if individual growers will not cooperate with sound sales principles, one means of bettering packing house returns will be lost.

As a nation we are still not decided whether competition is the life or the death of trade. Fifty years ago we thought only of consumer-protection, because consumers were as a flock of sheep preyed upon by wolves. Today, it is a different picture—Daniel in the lions' den, and not enough to go 'round. Dropping metaphor, we have found our anti-trust legislation not merely an act to protect the consumer, but one to starve the producer. Hence, the exemption of farmer organizations, and the growing realization that other

producers need consideration. The record of the raisin growers and the record-in-the-making of oil producers are warnings too plain for even veteran trust-busters to ignore. We should not ignore them. I think that we may properly, and without danger of legal interference, consider the stabilization of our marketing. How are we to do it?

There are various factors which may aid in stabilization, and one is quality of production. This is entirely a grower problem. Entirely? Well, nearly. Besides thought and labor, a date crop needs money; and the packing house has a responsibility there. But grower-offerings of unreasonable proportions of undesirable dates can only raise packing house costs and selling problems. It is just one more vicious circle; but, in this case, the egg (that is, the date) came first. It is a grower's problem.

Another factor is standardized pricing, and that presupposes standardized grading and packing. Nothing would so steady demand, I think, as such standardization. Steady demand, an even flow of merchandise in accustomed channels is the ideal of the merchandiser. To illustrate from my annual experience: We have been supplying a grocer in our town with a date that he sold in fair volume and at a satisfactory profit. It was dependable business, mutually satisfactory. When he wanted more he had only to give us a ring to get the same goods. But each year he comes down here, or some grower on the way home steps in and offers him a "bargain." He buys and, maybe, sells, maybe, not. If he sells, he cannot repeat, and he has interfered with his customer demand for the date he was carrying. It is a fact that each year he has stocked dates that were slow movers, or sold at a loss to close out. He reached for the nearest dollar, the immediate, not the far result. Our business has been interrupted; and, as what we pay growers must depend upon our sales, the growers ultimately are affected. The grower who reaches for the nearest dollar may be working against the welfare of the industry. I consider it the business duty of men in position to know, to tell the growers frankly the result of their many individual acts. Standardized grading, packing and pricing will eliminate among buyers the shopping disposition with its resultant irregularity. But how obtain this threefold standard? The answer we have had in the past was a movement for one selling organization which should determine prices, packs and grades, but practical difficulties have blocked that movement at the start. I see no use in trying to revive it. There are too many kinds and qualities of dates, and too many packers large and small, to make of probable success a dictated standard. The practical difficulties remain.

It would be gratituous, even unkind, if I taxed your attention this warm afternoon with a repetition of marketing troubles, but without one least suggestion how to meet them. The suggestion I have to offer I have considered from time to time for several years; but I have not given it the study it may deserve; and, so, I offer it with due reluctance. As I said at the outset, you are entitled to carefully considered conclusions, rather than a suggestion dug up because I must say something.

For a number of years before my entry into the date business a dozen years ago I was engaged in oversight of a citrus property, groves and packing house. As the house was a member of the California Fruit Growers Exchance, I became versed in Exchange operation. In selling, Exchange fruit is sent to auction and private sale markets; and the sales managers get bids from private markets and compare with auction prices. Did you note that—they compare with auction prices. In other words, the auction market functions as an exchange, the stock exchanges, the grain pits, produce exchange, etc., to establish prices. Upon these prices great transactions are based. They govern business in their lines over all the country. They do more, many of them; for they establish grades of wheat, corn, produce; and, in citrus, even determine the pricing of brands. In a word, they provide a standard for determining the sale of the country's production. But, in dates, what sales standards have we? Are there not too many grades of price and pack to say that we have any standards?

It may not be timely to consider a date auction. We may have too small production, although I don't think so; and it might be that not enough packers would patronize it. Moreover, for the first week or two it might be a real slaughter of the innocents. But such a slaughter might prove to be really cheap advertising. In a reasonable time, with offerings fairly controlled, buyers would set their own values on each variety, grade and pack,—yes, and on each House brand, just as in citrus. What other influence would so constrain us to make standardized offerings of our dates as the day by day price-judgment of the trade?

Grades in Date Marketing

By T. J. Gridley, Thermal, California

WHILE commercial date growing in the Southwest may be said to have had its inception with the first importations in quantity of Old World date offshoots 17 or 18 years ago the extremely severe losses that were suffered by the industry during the first decade or so of its growth, in attempting to root early cuts of domestic offshoots, had a very material effect on the rate of increase in fruit production in later years.

Instead of the healthy increase that normally might have occurred five or six years ago, had early plantings been more successful, production was held at such a comparatively low level during the intermediate years that American grown dates failed to quite pass out of the novelty class to be sold rather too easily to an interested public often at far higher prices than actual values might perhaps justify.

The sharp increase in production of the past season or two with every prospect of material gains in the immediate future indicates quite clearly that if the date industry is to develop on a basis that will be profitable to growers readjustments of present selling methods are in order and better distribution facilities must soon be provided.

Thus it appears that after having devoted the early years of its growth mainly to the solving of cultural difficulties the date industry now finds itself on the point of adding a brand new member to its already numerous family of problems—Marketing—bringing with it also some little brothers and sisters, one of which has quite a long name and is called The Development of Packing

House Methods to Properly Handle Dates Under Quantity Production.

These latest star boarder acquisitions to the family of date growers' pet worries seem to have enormously healthy appetites and the task of curbing and bringing them under such control that they may not develop to undue proportions and cast the clouds of doubt, distrust and dismay over the industry is one that calls for all possible tact, patience and clear thinking at our command.

Whether or not the successful packing and marketing of American grown dates on a profitable basis will, in the final analysis, be accomplished by one or more co-operative organizations, by private companies, by individuals or groups of individuals or by agencies as yet unthought of, is a question to which probably time alone can find the correct answer.

Before we proceed very much farther along the road leading toward the solution of our difficulties I would like to speak of something that has been growing right up in our path all along and which we have all very quietly and carefully stepped around in the hope that it might never become uncomfortably large. I am referring to the matter of the establishment of commercial grades for dates. I am not recommending the setting up of grades for dates at this time but I would like to present the subject this morning for discussion. I do not know that it will be possible to establish grades for dates. There are undoubtedly many difficulties in the way. The numerous varieties grown, diversity of soil and location, care of palms, affecting quality and time of maturity, variability of seasonal weather conditions, variation of fruit on individual clusters, differences at present that exist in processing and packing methods: these are all factors that must be reckoned with.

Date Sales from Growers Standpoint

By Bryan Haywood, Indio, California

I HAVE been asked to speak on date sales from the grower's standpoint, the idea being to bring out something of benefit to him.

I have been twice a member of the Deglet Noor Date Growers Association, once a member of the Date Corporation of America, and am now, temporarily I hope, packing and selling my own fruit.

In all three concerns my chief interest has been in the sales end, so have had a rather wide experience in the selling of our dates.

The net result of this experience leads me to believe that the less the grower has to do with the selling of his product, the better.

Marketing anything, in these days of fierce competition is necessarily a highly specialized operation, and is taking a lifetime effort of the best business brains in the country.

The individual grower has no such experience, and by himself, is helpless.

By far the greater part of our national farm production is in the worst condition it has been since the beginning of agriculture.

All the highlights of successful marketing of farm products today, are the result of co-operative effort among the producers, and our national failure of fair sales returns to the producer is due to the lack of such co-operation, both in restriction of production and marketing.

The most impressive example of successful co-operative marketing I have ever seen was the work of the California Walnut Growers Association in 1921 or 1922.

They had an extra heavy crop, and the wholesale grocery trade, which was their sales outlet, were in a bad way financially through the tremendous post-war slump in sugar, which hit them very hard.

It was also a time of retrenching—no one knew what he could sell, and all prices were falling—everyone in all lines of trade buying from hand to mouth.

Under these conditions, the wholesale trade were not in shape to place advance car lot orders, as usual, and especially for such a luxury as walnuts.

The Walnut Association didn't ask them to; instead they financed themselves, the warehousing of their crop in all the large cities of the country, and said to their wholesale customers, "There they are, help yourselves from day to day as you can sell them —the price is ____cents per pound."

The result was that they sold their entire crop and at their own price.

Had they tried to force sales to their trade along usual lines, they would have met great sales resistance, and certainly realized a much lower price.

Our date production is so limited in location, area and tonnage, that our sales problem is a joke compared to almost any other product of the soil, and yet here we are treading the same old paths of individual effort that have invariably led to disaster in every soil product in the past.

We have four different wholesale sales departments working on a national scale, each duplicating the effort and expense of the others, and what is even worse, with no consistent plan of marketing our dates.

I am convinced that the future will see one sales office and only one, selling the entire output of American grown dates.

Given **Standardization** of pack, it will make little difference how many packing plants there are. but it is absolutely essential that there be but one sales office—and it will come as surely as the sun rises.

If we growers have sense enough, it will be grower controlled; if not, privately controlled, in which event we growers will take less for our dates.

A strong effort is being made at this time by the Deglet Noor Date Growers Association along these lines, which is certainly a step in the right direction, and I most earnestly hope it will succeed.